[H.A.S.C. No. 101-10]

# HEARINGS

ON

# NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 1990—H.R. 2461

AND

# OVERSIGHT OF PREVIOUSLY AUTHORIZED PROGRAMS

BEFORE THE

## COMMITTEE ON ARMED SERVICES
## HOUSE OF REPRESENTATIVES
ONE HUNDRED FIRST CONGRESS

FIRST SESSION

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RESEARCH AND DEVELOPMENT SUBCOMMITTEE HEARINGS

ON

# RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

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HEARINGS HELD

FEBRUARY 23, 28, MARCH 2, 7, 9, 14, 15, 21, 22, AND 23, 1989

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U.S. GOVERNMENT PRINTING OFFICE

98-110 WASHINGTON : 1989

H201-75

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VI

101ST CONGRESS
1ST SESSION

# H. R. 2461

To authorize appropriations for fiscal years 1990 and 1991 for military functions of the Department of Defense and to prescribe military personnel levels for such Department for fiscal years 1990 and 1991, and for other purposes.

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IN THE HOUSE OF REPRESENTATIVES

MAY 24, 1989

Mr. ASPIN (for himself and Mr. DICKINSON) (both by request) introduced the following bill; which was referred to the Committee on Armed Services

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# A BILL

To authorize appropriations for fiscal years 1990 and 1991 for military functions of the Department of Defense and to prescribe military personnel levels for such Department for fiscal years 1990 and 1991, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

**SECTION 1. SHORT TITLE.**

This Act may be cited as the "Department of Defense Authorization Act, 1990/1991".

* * * * * * *

# TITLE II—RESEARCH, DEVELOPMENT, TEST AND EVALUATION

**SEC. 201. AUTHORIZATION OF APPROPRIATIONS.**

(a) FISCAL YEAR 1990.—Funds are hereby authorized to be appropriated for fiscal year 1990 for the use of the Armed Forces for research, development, test and evaluation, as follows:

(1) For the Army, $5,648,839,000.

(2) For the Navy, $9,590,546,000.

(3) For the Air force, $14,551,900,000.

(4) For the Defense Agencies, $9,469,600,000, of which—

(A) $309,300,000 is authorized for the activities of the Deputy Director, Defense Research and Engineering (Test and Evaluation); and

(B) $194,500,000 is authorized for the Director of Operational Test and Evaluation.

(b) FISCAL YEAR 1991.—Funds are hereby authorized to be appropriated for fiscal year 1991 for the use of the Armed Forces for research, development, test and evaluation, as follows:

(1) For the Army, $6,027,700,000.

(2) For the Navy, $9,251,127,000.

(3) For the Air Force, $13,505,300,000.

(4) For the Defense Agencies, $10,625,600,000, of which—

(A) $434,700,000 is authorized for the activities of the Deputy Director, Defense Research and Engineering (Test and Evaluation); and

(B) $160,400,000 is authorized for the Director of Operational Test and Evaluation.

* * * * * * *

# LONG-TERM RESEARCH AND DEVELOPMENT STRATEGY PANEL

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Thursday, February 23, 1989.*

The subcommittee met, pursuant to call, at 1:30 p.m., in room 2118, Rayburn House Office Building, Hon. Ronald V. Dellums (chairman of the subcommittee) presiding.

## OPENING STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The Subcommittee on Research and Development will come to order.

As the new chair of this subcommittee, I would like to first welcome all of my distinguished colleagues who are members of this subcommittee.

I look forward to working with each of you as we begin our deliberations on the R&D budget for fiscal year 1990.

I believe that this subcommittee is unique. We, maybe more than any other committee in Congress, have the opportunity to think in the long term.

To visualize the world of the future, to look at what we may need not only for our security, but for that of the world, to analyze the threat assessments presented by the services in more than just political terms, and to look at how proposed weapons systems meet that threat and our vision of the future.

The delay in the confirmation of the Secretary of Defense and receipt of a revised defense budget from the President of the United States has given us the chance, indeed perhaps an extraordinary and precious opportunity, to take a few days to step back and look at some broader policy issues: long-term planning; whether we should increase the portion of the R&D budget that goes to basic research; and, the impact of the percent of American R&D dollars that go to defense.

Today we will begin by looking at long-range planning 10, 15, 20 years into the future.

What do we see as the threat in the future and are we planning our weapon systems to meet that threat? Will the systems be obsolete before they are deployed? Are we pushing systems through R&D and into full-scale development before we really have the solutions to a lot of the problems?

It seems to me that these are reasonable and logical areas to pursue.

As we know, the development cycle of our military systems typically has been in the 10-to-15-year range. This necessitates good, long-range planning so that when we get to the end of our technology developments, we have not developed obsolete or duplicative weapon systems with all of the attending problems that that presents.

Today we will hear from three individuals with extensive backgrounds in defense policy and technology who will hopefully give us some insight into these areas.

I would like to welcome before the subcommittee Professor Al Carnesale, Professor of Public Policy and Administration and Academic Dean of the Kennedy School of Government; Dr. Charles Herzfeld from Aetna, Jacobs & Ramo; and Mr. Walter Morrow, Director of the Lincoln Laboratory at MIT.

Thank you for taking the time from your demanding schedules to be with us today to discuss this important topic. I believe each witness has a prepared statement to present to the subcommittee. We will wait until after all the testimony has been received before we begin the questioning.

The Chair might also indicate that it is the Chair's desire not to pursue the 5-minute rule because my thought is that as Members show up to a committee, it is a demonstration of their interest, their concern, their desire to seek knowledge and engaging in the 5-minute rule often precludes us from a coherent exchange with the witnesses.

We allow ourselves to get caught up in the technology of watching a clock as opposed to absorbing information. So if my colleagues would operate with reason, the Chair's desire would be to yield to them at the appropriate time in order to pursue their areas of interest and concern.

The Chair would indicate that when we do come to the witnesses, the Chair would like to pursue the following order of presentation: Dr. Herzfeld, Professor Carnesale, followed by Dr. Morrow, who will be our clean-up hitter.

Before we pursue that, the Chair would yield to my distinguished colleague from Alabama, the Ranking Minority Member of the subcommittee, Mr. Dickinson, for such time as he may consume for such comments he may deem appropriate at this time.

## STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DICKINSON. Thank you very much, Mr. Chairman.

I join my chairman in welcoming you as our witnesses before the first official meeting of the R&D Subcommittee for this session of Congress. We appreciate you finding the time in your schedule to appear.

The R&D Subcommittee's new management will be attempting to develop a long-term perspective with which to assess the relationship between military research, development programs and the U.S. defense policy.

As an initial step in this direction, we have asked our witnesses to present their views on what the long-term factors driving U.S. policy and programmatic decisionmaking should be and will be in the future.

As we are all aware, the congressional defense budget process, if not the budget itself, is highly politicized and short term in nature. Consequently, even if we eventually develop a consensus on a long-term framework or perspective, our ability to rationally and cost-effectively proceed will remain severely limited by our own processes here in the Congress. The problem is not new, nor do there appear to be any easy solutions.

Accordingly, I look forward to our witnesses' testimony today and we would hope to have these issues resolved before we adjourn in several hours.

Let me say also that we have had some changes as to jurisdiction in areas of influence on the committee. Perhaps this will be folded into your comments here today.

Traditionally, we have had the R&D Subcommittee with its jurisdiction and Procurement with its jurisdiction. But, there has not been a very definitive line and we have had a lot of jurisdictional and turf battles in the past.

There have been many occasions when the R&D panel determined that a program was no longer viable, that it hadn't proven itself, that it should be terminated, and we would zero the budget request. At the same time, the panel on Procurement would have a different opinion—mainly because they don't have the same input—they would authorize expenditure for procurement when we have already killed the program. The reverse is also true. Sometimes we in R&D will say, "This has promise and we think this is worth doing," and we will continue development. If the Procurement Subcommittee which has the authorization for the full-scale development funds, says "We don't like this," they can say, "No matter how much research and development they do, we are not going to buy it."

The chairman and I have discussed this problem with the chairman of the full committee, Mr. Aspin, and we have agreed that we would continue in the future as we have in the past. We will do our research and development business here, the Procurement Subcommittee will proceed on its own, but where there are major areas of disagreement in the major systems, not in the everyday cats-and-dogs-type thing that we would then have a joint hearing on mark-up in those areas.

In that respect, we have agreed that it will be handled differently in this Congress from what we have done in the past and I think it is a good way to proceed.

In those areas, we will get together and work out our differences as best we can, but we will continue to do business in the future much the same as we have in the past. With this agreement between Chairman Aspin, Chairman Dellums and where there are differences, we will get together and try to iron them out and avoid some of the problems that we have had in the past.

So with those statements, let me again welcome you here and thank you, Mr. Chairman, for the opportunity of welcoming our guests.

Mr. DELLUMS. I thank the gentleman for his opening statement. The gentleman yields back his time.

Mr. DELLUMS. Dr. Herzfeld, welcome and you may proceed in any fashion you choose.

## STATEMENT OF CHARLES M. HERZFELD, VICE CHAIRMAN, AETNA, JACOBS & RAMOS TECHNOLOGY VENTURES

Mr. HERZFELD. Mr. Chairman and ladies and gentlemen, it is a great honor to be here, particularly under the circumstances that you have pointed out. It is a very special hearing and I am gratified to be able to participate in it.

I reside in Secaucus, New Jersey, and am appearing as a private citizen and all my remarks are to be considered in that fashion. That way we will keep everyone on the right track.

I have a statement for the record and I would like, with your permission, to have that introduced into the record——

Mr. DELLUMS. Without objection, so ordered.

Mr. HERZFELD. I will make statements from it and then will be open for discussion.

To find a suitable R&D strategy for the U.S., we have to take a pretty broad perspective.

It is a long-term problem. It is not a problem for today or tomorrow. It is a 10-or-20-year problem and we have to learn to look at it that way and look at the ins and outs of it.

Fortunately, history helps us because for 40 years this country has had a marvelous system, an outgrowth of what we learned in World War II to bring science, technology, industry and people together and people and come out at the end of the process with an extraordinary military machine which the country could use effectively.

A key concept in all of that was that we would always have to be able to make up for inferiority in numbers with superiority in quality.

We never felt we would be able to match the numbers of any and all potential adversaries and the only way we could see handling this kind of situation was with a superiority in quality based on our industrial and scientific base. That has worked.

We have not had a major war since World War II and that is a very long time if you think about world history.

So I think there is a certain amount of experience behind it.

Now, this qualitative superiority, however, takes scientific discoveries and technology inventions and a deep understanding of military operations, and you have to bring these all together with industrial know-how. In this process, over the last several decades, we have produced really extraordinary weapon systems, the B–52, the Minuteman, the Polaris, the U–2 military satellites and the rest.

This system of acquiring weapons was a real American invention; it was the comfort of our allies and the envy of our foes. There is a real danger that we are dissipating this advantage largely by lack of attention and understanding.

There isn't any bad will involved here. It is just that people have gotten used to the system and are taking for granted subtle things

that need to be in good balance, but we are beginning to lose this good balance. I would like to recall for the committee some of these policy elements.

Much of the work I will be talking about was carried out under the aegis of the Commission for Long-range Strategy. It had a number of working groups supporting it.

I was the Chairman of the Technology Working Group and what I will present is clearly very much influenced in this. However, I am not reporting formally on the work of this working group because that would be premature. The working group report is supposed to come out in a few weeks, but you are getting a preview here and I am happy to provide that.

We have seen a weakening in the weapon acquisition process through a number of factors. There has been an erosion to the commitment of qualitative superiority. The serious and thoughtful people say, "Isn't qualitative superiority dangerous," to which I would say, perhaps if the numbers on both sides are the same. But if you have to make up for an imbalance in numbers, you need the qualitative superiority very badly.

We have had a decline in the funding for the technology base over the last 20 years, the data are summarized in the material presented for the record, we have found an increased bureaucratization of the process of developing and using our technology base and of acquiring weapon systems.

This, in turn, has led, as in all bureaucracies, to heavy risk avoidance. People are afraid to take risks in bureaucracies. That is one way you can tell that you are dealing with a bureaucracy, when you see that nobody is willing to take risks. But life is full of risks and they have to be measured and sensible risks have to be taken.

We found an extremely destructive adversarial process at work between the DOD and industry. This has grown up over the years. There were lots of reasons for this, and I believe that there is enough blame for everyone. We all have had our hands in it. But it is time to fix it because I don't think we can go on this way.

Finally, in all candor, I have to say that there has been over the last 25 years a large increase in Congress managing details of DOD programs. This has grown to an extent that was undreamt of 25 years ago and that has created many problems.

We want to learn how to do better with this problem, I believe, as well, and you alluded to some of these, as did your colleague, Mr. Dickinson.

The technology base, as I like to say, is it isn't that it is bad. America still has the best science, broadly speaking, of any country in the world. There are a lot of runner-ups and some are very close, but where do most people want to go to get a Ph.D. in science or to work on a post-doctoral fellowship in science? They want to come to the United States. On this sort of thing people vote with their feet, so we can be reassured by that.

We still have very good technology. Our industrial laboratories and our Government laboratories, particularly the one represented by the distinguished clean-up witness, are excellent, the technology in these places is outstanding. Then what is missing? What is miss-

ing is that, gradually it has gotten much harder to exploit that technology and to use that science for practical purposes.

Again, there are exceptions. In America, we still can be very proud of our aircraft industry. It is without question the best in the world. But there are not very many such broad industrial sectors that we can be very comfortable with. We need to do something about that.

The drop in funding in the advanced technology over the last 25 years has caused a major gap in our understanding of things that other people do understand, and our ability to use technology. I believe this trend has to be reversed, and will address this later on.

The low-risk approach has come out in a form that I consider particularly pernicious, a form that one runs into it all the time in bureaucracies. If you come up with a new idea, people say, "It won't work," and if it works, "We can't afford it." That is a wonderful way to stop any good idea and many do get stopped.

I think we are all looking to you and to this committee to set a good, careful course and then hold to it and not let people say it can't be done or you can't afford it when you get it. These arguments have to be answered. One has to show that it probably can work, that it makes sense to buy it, but not allow the premature cut-off of a good idea. We will look to you for a lot of help in this as the years go on.

Let me remind you that we also have unique opportunities. All the news is not bad. I think our military forces are now better in quality than they have been in my memory. I get to visit troops in the field a fair amount and they are outstanding. Their morale is high, their equipment is good, they know what they are doing to a degree I have not seen before. That is very, very important.

It is as important that the American people remain dedicated to national security, but I think it behooves all of us to explain to the American people what needs to be done and why.

I see our function as a collective function, one of being educators and explainers of why this is important. A number of things need to be done.

First of all, the crooks should be punished to the full extent of the law. The things we read about breaking the law and inappropriate behavior is wrong and should be taken care of.

Second, the weapon acquisition process, and that includes the technology front end of the process, does need to be rejuvenated because it is rusting. To achieve these, we need a long-term strategy.

Mr. DELLUMS. Repeat that last comment.

Mr. HERZFELD. The acquisition process from the front end of buying hours of good scientists, time to the end when the trained troops come out with new weapons, this whole process that, as you said, takes 10, 20 years, I think has to be rejuvenated. It has grown old and is rusting and needs some oil in the joints, needs some vitamin pills, maybe it needs a bypass operation here and there. These are some things we could suggest.

We do need a long-term strategy that connects where we want to go with where we are, objectives with resources in a practical way. That is something that as a country we are not terribly good at doing and we don't spend a lot of time at it.

Your committee can help us. Keep asking, "what is it for?" "Why do you want it?" "Why is it important in the long run?" We don't spend enough time thinking about that and I think you are quite right the way you put it in your introduction. We need to understand more clearly what kinds of military capabilities we need.

One of the important things that came out of the long-range strategy commission was the view that there are more conflicts to be worried about than just two, the ones we usually worry about, a conventional war in Europe with the Soviets and the Warsaw Pact or an all-out nuclear attack on the United States out of the blue. Those are important contingencies and dreadful, but they are also probably the least likely things to happen. Every week something happens, and thank God it isn't one of them.

We have to be prepared for all the other things that happen and be better prepared than we have been. We have to, as I keep saying, make more efficient the mechanisms for turning technical and military concepts into weapon systems and military equipment.

In order to achieve these high goals, we really need to work very hard at achieving a bipartisan working consensus between the Congress and the executive branch about national security.

I remember with great fondness the days of the late 1940s, early 1950s when that existed, and while there were bitter arguments about everything political in the domestic arena there was a solid consensus about what happened at the water's edge.

I think we need it. I think we still need to debate what should happen at the water's edge, but we must try and reach a consensus and once reached, stick with it while it is workable. I think it behooves us in ever part of this process to consider that very seriously.

What has been happening lately is, I believe, very constructive. Basically, a new start must be made with relations with the defense industry. Instead of seeing the defense industry as the antagonist, I wish that both branches of the Government could treat industry as partners in the planning and thinking part of the process and then deal strictly at arms-length in the shaping, awarding and managing of the contracts. I think that is the way to do it and I hope we can get to such an approach.

That way we would get the benefit of the thinking of a large number of very smart and very experienced people early on when the thinking goes on, and then, when the making of the choices comes, we then say, "All right, ladies and gentlemen, please wait in the next room; we will do our thinking now and we will tell you who has made it to the team to do the work. Then we are going to run you just like any contract, very hard nosed, but with understanding and fairly, and at arms-length."

It is harder to proceed in this way, but I think it is worth trying, and I advocate strongly that we try. I think the benefits will be large.

Another key item that I know a number of Members of the committee are very concerned about is the pay of top level executives. I hate to raise the subject in these halls at this time. This must surely be one of the most aggravating and unpleasant ones, but

something has got to be done about a relatively small number of positions in the executive branch.

It is true that the average remuneration for technical people is below the average of what they can get in industry, but not catastrophically low. What is catastrophically low is what one can offer seasoned executives at the prime of their career. They either have to be very wealthy or have to take a pay cut of a factor of two to three if they come into Government. That is very hard to ask people to do. Some can do it, but if they have children to put through school and don't have significant private means, they can't take the job. It is that serious.

Now, there are not many positions in these top levels of technical management maybe 20 or 30 in the whole Government, but unless we find a way to solve this problem, we will have a major problem getting the quality of leadership at that level of the Federal Government that we all need.

I leave this suggestion with you: I urge you to explore schemes that are in being. NIH has some special arrangements for special people, the nuclear Navy has some special incentive pay. There is flight pay. There are all kinds of devices that have been used legally and with full consent of the Congress to alleviate the situation, but this is the first time that we have a very small group of people that are very essential for the proper functioning of the defense establishment who are really exposed and they need help.

When we buy our weapons systems—another subject—we have to pay more attention to the fact that the platforms, the ships, the airplanes, the tanks last for 20 years, some maybe 40 years, but that the missiles, the guns, the engines, the infrared equipment and so on that goes on the platforms need to be upgraded every five to 10 years.

Therefore, we have to go much harder in the direction of having modularized designs so we can, when we need to, take out the subsystems, the weapons and electronics, and put more advanced versions in.

The opportunities for this are endless. We are doing some of it, but we could do more of it and plan it better, and I assure you that the cost-effectiveness ratio would improve when we do that. We would get much more bang for the buck if this is done properly.

I urge that you put all the major ideas through this sieve. Does it meet this kind of criterion? Is it possible to upgrade easily when needed? I think there is a lot of extra effectiveness to be had here.

Just very briefly, of course our advanced standing in computer technology should be exploited as much as we can. There are really extraordinary things coming down the pike that we need to introduce quickly and intelligently, the same with sensors technology. All of these make weapon systems possible in the near to intermediate future that will enable us to carry out particularly non-nuclear operations effectively and therefore raise the nuclear threshold significantly. I think that is in all of our interest to do that.

Finally, I would like to close with something, Mr. Chairman, which I found particularly fascinating with respect to your comments about long-range planning. Recently Admiral Gorchkov published a book about the Soviet navy. It is a recent book, just trans-

lated. I have here one page of it which I thought would interest the committee.

This page explains the interrelationship of forecasts and plans for the creation of naval arms according to the basic life cycle phases as seem by the Soviets—I will read for you the four different time horizons considered. One to 5 years Gorchkov calls concurrent. Our FYDP, which we hardly can make stick for 5 years to him is "concurrent." "Short range" is 5 to 10 years out. "Mid-range" is 15 to 20 and "long range" is 25 to 30.

They try, how well no one knows for sure, they try to think and work with this time scale. This gives them a long-term perspective which occasionally may make them do unproductive things, but in the long run they do well, because they have built a military machine that is so much better than anything else they have built, it is the only part of their society that gives us concern.

I don't think we would want to do anything like that in this country, but it is an indication of how much in the other direction we have gone the way we have been doing things.

Thank you very much, ladies and gentlemen. This concludes my remarks.

Mr. DELLUMS. Thank you very much for your very detailed and interesting presentation.

## Prepared Statement of Charles M. Herzfeld

My name is Charles M. Herzfeld, I reside in Secaucus, N.J. Mr. Chairman, Ladies and Gentlemen. It is a great honor to be asked to comment on the national security aspects of the DOD R&D policies and programs.
I am appearing and testifying as a private citizen, and not in any official capacity.

For forty years, US and allied national security policies have been built on the pillars of deterrence of nuclear and non-nuclear war with the
Soviet Union and its allies, deterrence that is based on real fighting capability and is therefore credible. A second pillar has been the commitment to meet and defeat lesser aggressions from any source, wherever it threatened our vital interests. Underpinning all this has been the realization that only through qualitative superiority over any foes would we be able to deter attack, or defeat it if deterrence failed. This qualitative superiority was understood to be required to make up for quantitive inferiority, slower response because of geographical factors, etc. As a consequence, this country established a unique process, first tested in World War II, for supplying our troops with the best equipment that could be made available. Thirty to forty years ago, this process,

which takes scientific discoveries, technological inventions, deep understanding of military operations and industrial knowhow functioned well and produced extraordinary weapons systems, the B52, Minuteman, Polaris, U-2, satellites and the rest. This process, in a very real sense was an American invention and was the comfort of our allies and the envy of our enemies.

All this has begun to change. Over the last twenty years we have seen a gradual weakening of this marvellous process, imperceptible at first, so gradual that the seriousness of the change was not apparent until now, so gradual that some still don't see the danger and prefer "business as usual". We are living with a steady erosion of the commitment to qualitative superiority. We have seen declining funding for the defense technology base, reduced willingness to take calculated risks to advance the state of the art, explosive growth of a highly destructive adversarial process at work between the DOD and defense industry, and a dramatic increase in congressional micromanagement of defense programs.

These changes have been caused by many factors and all parties to the process have earned their share of blame. But I am convinced that we can and will rise to the immense opportunity to re-establish a national consensus on these fundamentals of national security.

Here are some of the specifics that have gone wrong:

1. The Technology Base is rusting. Though national support of all basic science has effectively kept up with national growth and inflation, the resources devoted to defense related technology have been shrinking since the late sixties.

   They rose again in the middle 80's, but have again been declining since then. (The detailed data can be found in "Discriminate Deterrence", the 1988 report of the Commission on Integrated Long Range Strategy, P. 46). (Also see Fig. 1) This drop in resources has produced a shortfall in critical technical work of 25 to 30 billion dollars, equivalent to over a hundred thousand person years of technical effort, or some ten thousand engineers and scientists per year! In addition, industrial "independent R&D", (performed on defense problems and partly paid for by DOD) amounting to many billions a year, has become much less innovative and exploratory, and is now largely devoted to cost and risk reduction. Yet the results that come out of this total effort are the raw material of new technology essential for a vigorous, high quality defense systems program. This is the seed corn for the process, and we are eating it. The Technology Base is rusting. This cannot be allowed to go on.

2. In parallel with the drop in funding for advanced technical work has gone a profound change in the atmosphere in which this work is done. This has gone from the highly innovative style of the 50's and 60's to a low risk, play-it-safe approach. Daring new technical concepts are now easily killed with: "It won't work, and if it does we can't afford it". No surer way could be found to impose long term technical stagnation on our military capabilities.

3. Recent cutbacks in DOD budgets have begun to undermine the integrity of the whole planning and budgeting process. Today, more than ever before, cost estimates at every level are biased toward low figures, to give programs "a chance". All this adds up to unsustainable expectations, which will surely undermine the process ever more.

4. In part because of these budget problems (but, in my view also fuelled by other factors) a highly emotional and confrontational atmosphere has grown up between the government and defense industry. In my 35 years of participating in the process or observing it I have <u>never</u> seen such a poisoned atmosphere or so much harm done. Mutual distrust, fear, anger and frustration rule.

Let me remind us again that these problems offer a unique opportunity. After all, not all the news is bad. Our forces have never been stronger, our opponents seem to be wavering and forced to address their weaknesses. The American people remain dedicated to national security. We must show them that the needed improvements can be achieved.

In these days of a drumfire of stories about $500 hammers and indictments of industrial and government people on charges of fraud, it may seem Quixotic to call for better, more cooperative relations among all in the DOD procurement process. But let us be clear:

> First, crooks should be punished to the full extent of the law, else confidence in the very processes of government will be totally undermined.
>
> Second, the total weapon acquisition process must be rejuvenated, otherwise it will sink ever more deeply into a morass of mediocrity, inefficiency and politics.

What needs to be done is clear. Continued qualitative military superiority requires a few critical things:

1. A long term strategy, that specifies what we wish to achieve in this dangerous world, how we plan to do this, and what resources we must devote to the effort. Descriminate Deterrence provides such a framework.
2. A steady flow of the raw materials from which weapons are made: excellent science and engineering, and innovative military concepts for systems and operations. These require an atmosphere in which innovation and creativity can flourish, are welcome and rewarded.
3. A clear and realistic view of what military capabilities we would need under different contingencies, and how we would employ these.
4. An efficient mechanism for turning technical and military concepts into weapon systems that meet the needs identified above.
5. A steady dedication of adequate resources to long term projects, as well as application of resources for quick reaction to various unusual contingencies.

These concrete steps must be taken in order of priority and importance:

1. A bipartisan working consensus between Congress and the executive branch covering clear national security objectives and management approaches must be established.
2. Part of this consensus must include a thorough revision of the budget process. Realistic budget levels must be agreed to, stability in plans and funding re-established. Microscopic examination of budgets must be curtailed by restructuring budgets into fewer, larger functionally meaningful items, and two year funding commitments must be instituted. The connection between major budget items and strategic objectives should be laid out more clearly.

3. A new start must be made with Defense Industry, that treats suppliers as partners in the planning and thinking, and at arms length in contracting and program management.

4. The Office of the Secretary of Defense must be strenthened in management, resource allocation and systems procurement. The Joint Chiefs and the Commanders of the Combat Commands must take up more vigorously the role assigned them in the Reorganization Act of 1986. Together OSD and JCS must work out a clearer vision of military strategy.

5. The steps must be taken that are necessary to restore the inventiveness and creativity of the defense technical community: Larger R&D budgets, growing for some years even in constrained or shrinking overall DOD budgets, are needed to restore the vitality we are losing. Better personnel policies achieving pay comparable to the private sector, money for lab equipment, closer interaction with the military users of future systems will help. Stronger technical representation in top DOD management councils is required. But most importantly generous rewards for truly excellent performance are required.

6. Our way of buying weapon systems must be improved. Weapon platforms last for 20 to 40 years in peacetime. They must be designed from the start to have some of their subsystems such as weapons, radars, communications etc. modularized, to make it easy to upgrade these regularly every 5 years or so, should major technical advanced become available. Some of this is being done now, but more can be done, and it can be done better. Budget stability will make it easier to plan such upgrades.

7. The implementation of a rejuvenated strategy is heavily dependent on the growth and use of technology. Three key technologies underlie the many specific technologies essential for implementing such a rejuvenated strategy. They are computer technology (architecture, hardware, and software), materials technology (structural and electronic materials), and sensor technology (sensor systems, components, and information processing). All three of these key technologies depend on each other, and this mutual dependence and support has fueled explosive growth in the capabilities made available by these technologies. In turn they depend on the basic physical sciences listed in table 1.

8. Some military technologies need to be developed more aggressively to support the rejuvenated strategy. Among these are:

Training aided by computer simulation
Stealth (low observables)
Small satellites ($C^3I$)
Accurate long range cruise missiles
Ballistic missile defenses
Nuclear, earth penetrating weapons
Advanced non-nuclear munitions
Airplanes, flight vehicles
Surface effect ships
Submarine technology and antisubmarine warfare.

In closing, let me say that we are facing a great challenge. Our forces are the best in memory, the tasks are more complex than ever, the uncertainties are greater than before. A reform is required, nothing less will do and this may be the best chance in a long time to achieve it. It is clear what needs to be done.

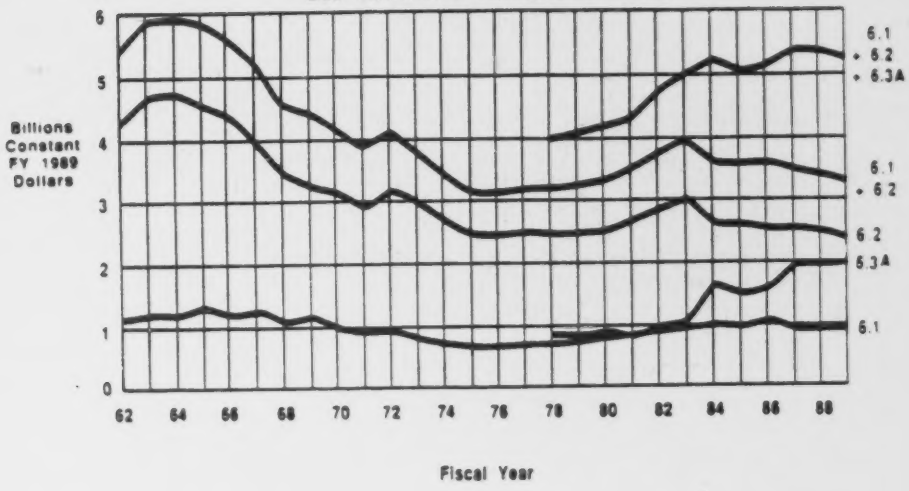
Thank you.

## THE SCIENCE & TECHNOLOGY BUDGET TRENDS

Front-end investment in the acquisition process generally includes funding for basic research (labeled Category 6.1), exploratory development (Category 6.2), and advanced development (Category 6.3). Since 1974, Category 6.3 funding has been subdivided into 6.3A and 6.3B. The former subcategory encompasses advanced development work prior to a deployment decision; the latter, advanced development after a deployment decision has been made.

Figure 1 provides an overview--in constant FY 1989 dollars--of 6.1, 6.2, and 6.3A expenditures since 1960. Funds for basic research (Category 6.1), declined sharply in the 1970's from their peak levels in the 1960's, but have remained fairly constant at around $800-$900 million per year since then. (Other sources of funds--from the National Science Foundation and the National Institute of Health, for instance--have led to large increases in total basic research, but many of these investments are not related to defense, or only indirectly so.) Funds for exploratory development (Category 6.2) also have suffered from a sharp decrease. This category of research translates basic scientific research (Category 6.1) into concepts with potentially practical applications. In 1964, funding for 6.1 and 6.2 activities combined was at its peak at $5.9 billion (in constant FY 1989 dollars). Today these activities are currently funded at around $3.4 billion, having slumped in the mid 1970's to a low 3.1 billion. Similar drops have occurred in the critical 6.3A type of development. The cumulative shortfall in Categories 6.1, 6.2, and 6.3A from the funding peak in the mid 1960's now amounts to roughly $25 billion.

**FIGURE 1:**
**DoD SCIENCE & TECHNOLOGY TREND**




DoD Science & Technology Report, March 1988

6.3A does not include SDI funding

Table 1 THE KEY TECHNICAL FIELDS

In order to provide a framework for an assessment of what might be possible in the area of militarily applicable technology for the next decade or two, five areas of major science disciplines are highlighted below. The focus is principally on the physical sciences and their probable application. It is very likely however that the biological and medical sciences will bring advances to technology (broadly speaking) that will be just as important in the long run as those derived from the physical sciences. However, these biology-derived applications are harder to predict at this time. The five major areas are:

1. The physics and chemistry of matter. This area includes quantum mechanics, solid state physics, particle physics, thermodynamics, statistical mechanics, chemical reactions, and biological physics and chemistry.

2. The theory of radiation and its interaction with matter. This includes electro-dynamic theory based on the Maxwell equations, the theory of relativity, quantum electro-dynamics, and related areas. Cosmology and the physics of the gravitational field are also part of this area.

3. Transport physics. This discipline includes the transport of matter, radiation and energy in very general terms. More specifically, fluid flow, heat transfer, and radiative energy absorbtion and reflection are included. These are generally based on the Boltzmann equation and its various approximations as well as the laws of physical optics.

4. Mathematical physics. This is perhaps the most basic area, which includes the application of new mathematics to computational physica, statistics, the theory of knowledge, and related areas.

5. Biosciences. This covers the physics and the chemistry of living matter at levels of organization ranging from the molecular through large scale plant and animal life all the way to the understanding of the ecosystems composing the biosphere. The scientific disciplines include the modeling of molecules and their interactions in the reproduction and growth of living cells; the chemistry of enzymes inhibiting or accelerating biological reactions; and the molecular basis for genetics and the associated investigations of congenital defects, the anatomy, physiology, and dysfunctions of the human body as related to the newly acquired fundamental concepts in biology.

The relevance of bioscience research to the problems potentially facing the Department of Defense include: (1) medical advances in the prevention of epidemics in the armed forces; (2) health services to active and reserve military personnel; (3) emergency services for combat-related wounds and other disabilities; (4) the effects of ionizing and non-ionizing radiations on humans and other organisms; (5) detection and protective mechanisms against chemical and biological agents used in overt or covert modes of combat; (6) evaluation of the threat posed by the possible use for aggressive purposes of chemical and biological agents by potential adversaries; and (7) sanitization, decontaminations and preservation of consumables for the armed services.

Mr. DELLUMS. We will now proceed to Professor Carnesale for such time as the gentleman may consume.

**STATEMENT OF ALBERT CARNESALE, PROFESSOR OF PUBLIC POLICY AND ADMINISTRATION AND ACADEMIC DEAN OF THE JOHN F. KENNEDY SCHOOL OF GOVERNMENT, HARVARD UNIVERSITY**

Mr. CARNESALE. I appreciate this opportunity to appear before the subcommittee today to express my views on defense R&D. My focus will be on strategic programs, and I will attempt to give attention more to how to think about the problem than to specific programs or to specific legislative processes.

My favorite question, which I find is always insightful, is what are we trying to do? I think that applies here as well. What are we trying to do with defense R&D programs?

The general goals should be the same as the general goals of our overall defense policy. One formulation of those is to reduce the likelihood of war, to reduce the consequences of war if it should occur, and to reduce the cost of preparing for and deterring war.

Within that, there are some specific goals for defense research and development. I put them in three categories. First, to guard against technological surprise, especially those surprises that might be exploited by an adversary; second, to develop counter-measures against any technological advances by an adversary; and, third, to exploit technological advances in ways that will serve our broader goals of reducing the likelihood of war, the consequences of war, and the cost of deterring war.

How can we tell which defense R&D programs will advance our interests and which ones will not? I wish I had a simple formula for distinguishing good technologies from bad technologies. There is none. Perhaps the most important advice I could give is beware of those who do offer a simple formula or tell you they have some simple way to decide which technology should be pursued and at what level of effort.

Perhaps the best way to illustrate some of the problems that are faced when we consider specific programs is to try to apply today's most popular simple formula. In that formula the magic word is "stability". You should pursue those programs that will enhance stability. Everybody is in favor of that.

The argument starts to fall apart when you ask the next question, what is stability? What is it that you are talking about? I can give you at least two definitions that people generally agree on, but they refer to very different kinds of things.

One is so-called strategic stability, and the other is sometimes called arms race stability. Generally people have a gut instinct for what those terms mean. Strategic stability exists when there is a dominance of incentives to wait rather than strike first. The decision is often couched in terms of striking first or second. That is never the decision. All you can do is decide whether to wait or to strike first. You never get to choose, unless you are positive that the other fellow is going to strike first, whether you are going to strike first or second.

Strategic stability exists when there is a dominance of incentives to wait, and that is related to the likelihood of war. One of our fundamental objectives is to reduce it.

Arms race stability exists when there is a dominance of incentives to reduce arms competition, and that is related to the cost of preparing for war or deterring it.

The action/reaction cycle is a gross over-simplification of the arms competition. Realize that the reaction invariably is to some anticipated action. You are not reacting to what the other guy did. You are usually reacting to what you think he is going to do and what he might deploy 10 or 15 years from now. That long lead time exacerbates errors in our judgment about what the other side will do and errors in his judgment about what we might do.

What I would like to do to try to illustrate some of my points today is to take some of the new technologies of weapon systems that are on our plate or on the Soviet plate and see what effects they might have on stability, which is what most of us are pressed to measure technologies against today.

Let me start with mobile ICBMs. It is a particular example of a survivable, we hope, counter-force weapon system. Now there is a critical distinction that must be made among weapon systems—is it my mobile ICBM or his mobile ICBM? If it is my mobile ICBM, the argument would go, then it is a survivable force for retaliation against Soviet targets, whether they be counter-force targets or counter-value targets. If it is his mobile ICBM, what is it for? We know it is either a counter-force weapon so he can use it in a first strike, or it is a survivable counter-force weapon to be kept in reserve while he uses his other weapons for the first strike.

There is nothing in our behavior or in Soviet behavior that indicates belief of what strategic theorists would tell us; namely that each side is better off if the other side's weapons are survivable. There is no indication that we or the Soviets believe that.

You will notice that we call his mobile ICBMs strategic relocatable targets. They are not in our view retaliatory forces that we want to survive.

What would be the effect of mobile ICBMs on strategic stability? If they are mine, they would enhance stability. If they are his, they would undermine strategic stability because they support his first strike strategy.

What about the effect of mobile ICBMs on arms race stability? Here the problem we focus on is monitoring the other side's deployment of mobile ICBMs. It is difficult to tell just how many he has and just where they are. We would like to reduce that uncertainty because that would enhance arms race stability by reducing the uncertainty against which we would have to react. But it is also true that the more you know about the disposition of the other side's mobile ICBMs, the better your chances of launching a successful first strike against them.

There is a tension between verifiability and survivability. Uncertainty tends to enhance crisis stability, and it tends to undermine arms race stability. These same arguments could be made about submarine-launched cruise missiles.

Let me take another controversial weapon system, ballistic missile defenses. Again, I would say the critical distinction is whether

it is my ballistic missile defense or his ballistic missile defense. Mine we all know would be intended to defend retaliatory forces or to complicate his first strike or to protect against an accidental attack but you remember what our reaction was when we first saw his ballistic missile defense. We thought it was to defend his nation against my retaliation or to defend his reserve forces and his command and control system and, therefore, was to be part of his first strike strategy.

So what is the effect of ballistic missile defense on strategic stability? If it is mine, it enhances strategic stability, and if it is his, it undermines strategic stability.

Suppose there is BMD on both sides. We have to think about the ABM Treaty because to some extent by deciding to have widespread BMD for ourselves, we are also deciding to free the other side from the bonds of the ABM Treaty so that he can have widespread ballistic missile defenses. This makes the problem more complicated, because while it is true that added BMD on my side would increase the number of our ICBMs and bombers that would survive, it is also true that those survivors would then have to penetrate Soviet ballistic missile defenses.

Will the additional survivors be more than offset by the reduced fraction that penetrate? By and large, if you look at today's ballistic missile defense technologies against today's kind of offenses and imagine comparable defenses on both sides, defenses tend to favor the side that would strike first, but that is not an immutable law of physics that goes forever. We could have better or more defenses than he has. If you assume that the defenses on both sides are not identical I have to know more about them in order to know whether they would enhance strategic stability or undermine it.

What about the effect of ballistic missile defense on arms stability? I have difficulty with the argument that suggests that if we deploy ballistic missile defenses, the Soviet reaction would be to reduce their offenses and not to deploy more widely defenses of their own. I know of no military man whose reaction to an expansion of the other side's defenses would be to reduce his own offenses. He would increase them and probably expand his defenses as well.

As an aside, I think the case for ballistic missile defense is not stability. I think the Reagan administration made a big mistake using that argument. That is not the case for ballistic missile defense. The case for BMD is that if deterrence should fail or if there were a small attack, BMD might reduce the damage to our Nation. That is an argument of merit. People can differ on whether or not it is a winning argument compared to the disadvantages of BMD, but it is an argument of merit.

I will take one more kind of weapon system to illustrate my point, the so-called non-nuclear strategic weapons. These are highly accurate long-range missiles with conventional warheads. Again, the critical distinction whether they are mine or his. Almost all analyses of the effects of non-nuclear strategic weapons assume that only we have them, or at least we have them ahead of him. This is not a complicated problem. I don't need computers to show me that if you give us something and them nothing, we are better

off. But it is not likely to be the case over the long run that we will have them and he won't.

Assume this were the case, that we had smart long-range weapons and he did not. What would be the effect on strategic stability? In terms of deterring the Soviets' first strike, I don't think anybody would claim it has any effect. Either they can destroy our arsenal or they can't. If all of our weapons had nuclear warheads on them, they would worry about them even more.

Proponents of non-nuclear strategic weapons claim that they would enhance extended deterrence by increasing the credibility of U.S. use of weapons against the Soviet homeland—that we would be more prone to use these conventional weapons against the Soviet homeland than to use nuclear weapons, which is probably true.

To the extent that homeland attack qualifies as a first strike, then non-nuclear strategic weapons are intended to undermine strategic stability. They are intended to make a first strike appear more likely. But if by a first strike you mean with nuclear weapons, then our use of non-nuclear weapons shifts the burden of escalation to the Soviet side. I think the burden of nuclear escalation is more likely to be taken up by the Soviets in the wake of an attack on their homeland with American conventional weapons.

What about the effect of non-nuclear strategic weapons on arms race stability? We have hardly begun to think about counter-measures. These things have to arrive very close to their targets to do any damage. Deception could make that difficult. The Soviets might match them in kind, but they might not. Perhaps the Soviets, not being as technologically sophisticated as we could not do as much damage to military targets with conventional weapons. They would do comparable military damage to us with much dumber nuclear weapons, but causing far more collateral damage. It may well be that unlike ballistic missile defense, this is a technology we ought to share with them. If we are going to have a strategic exchange with the Soviets, I don't want us using smart conventional weapons and them using dumb nuclear ones.

I believe that non-nuclear strategic weapons are likely to supplement, rather than replace, nuclear arsenals, and I would note the case for the smart long range weapon is not strategic stability, but rather it is for fighting in a cost effective way conventional wars, probably well outside each other's homeland.

What is to be learned from these examples? I could give many more examples in which conflicting objectives make it difficult to assess the merit of a technological change. I could illustrate the point with counter-force submarine-launched cruise missiles, with Stealth technology, with ASAT, with directed energy weapons, perhaps even with improving the survivability of command and control systems. I could even make the point with deep reductions or deployment of advanced sensors, and certainly with antisubmarine warfare.

My analysis leads to a generalization, which I modestly call Carnesale's theorem, that weapons are dangerous and destabilizing if and only if they are the adversary's weapons. There is no contrary evidence to this theorem, and the nice thing about this theorem is it applies in any language. I speak as an American. The technical

points I made today could apply to the arsenal of either superpower, but you cannot assume asymmetry in what the two nations stand for or what their intentions are.

There are technological differences among weapons that are of relevance to stability, but those technological differences are swamped by the differences of whose flag is on the weapon and, therefore, how you think it might be used.

Accordingly, there is no simple rule for distinguishing good technologies from bad ones. For each R&D defense program, you should ask, is this needed to guard against technological surprise? is this needed to develop counter-measures against technological advances by potential adversaries? and, is this likely to lead to technological advances that could be exploited to our benefit and that would serve our broader objectives of reducing the likelihood of war, the consequences of war should it occur, and the cost of preparing for and deterring war?

The answers, like the questions invariably are messy. Beware of those who offer a simple solution. If all the decisions seem to you to be very hard to make, it is because you are probably doing something right.

Thank you, Mr. Chairman.

Mr. DELLUMS. Thank you very much for an interesting opening statement, Professor.

We will move to our final witness on the panel, Dr. Morrow. You may proceed in any fashion you choose.

## STATEMENT OF WALTER E. MORROW, JR., DIRECTOR, LINCOLN LABORATORY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. MORROW. Thank you, Mr. Chairman, and members of the committee, for inviting me here today.

My name is Walter Morrow, and as you have heard, I am Director of MIT Lincoln Laboratory and a professor of electrical engineering and computer science at that institute.

I have spent on the order of four decades in the research business, virtually all of it at MIT. In that sense I might be considered an expert witness on trends in this area since the period just after World War II, and I will speak a little about that in a few minutes.

You have heard Dr. Herzfeld make a strong case for the importance of maintaining the strength of the DOD's R&D program, concerns about the need for reform in the management of those programs and concerns about the personnel managing them in the executive branch. I fully support these views of Dr. Herzfeld and will elaborate with my own thoughts on the subject in a few minutes.

Professor Carnesale, in turn, has talked about the issue of strategic weapons and how we ought to think about R&D for such weapons, and what I would like to do in the next few minutes is to talk about something a little bit different, namely the Nation's conventional or non-nuclear forces and their importance. We, of course, spend probably 70 percent of the DOD budget on these conventional forces, perhaps more than that, maybe even 80 percent, so it is a major part of the expenditure the DOD makes in manpower and equipment.

I would like to make this observation which parallels what Dr. Herzfeld said. Since World War II there have been countless conventional conflicts, and I don't have a number to present to you, but it is in the dozens, and it may be more than 100. Some of them have been large, and some of them have been small. The U.S. has been involved in some of them, some of the large ones, and it may well find itself involved in such conflicts in the future.

In fact, if the past is any guide to the future, we can expect this country will be involved in some form of conventional conflict, maybe large, maybe small, in the next decades.

In addition to this involvement with these large and small affairs, we have supported our allies with very large overseas commitments of men and materiel, both in Europe and the Far East. We have hundreds of thousands of troops in those countries.

Now, many have been concerned about an attack on those allies leading rapidly to a nuclear escalation because of our inability to cope with the problem with those conventional forces. This is the classic case in Europe of the country being—or the countries, plural—being overrun in a conventional attack and our turning to nuclear weapons as a means of stemming the onslaught.

Now, I think we all would want to avoid that eventuality, and what that says is there is a very strong premium on being able to cope with these problems with conventional arms and not have to resort to nuclear weapons. Now, we know with resources that are available in the defense budget today, and as we expect it will be in the coming years, that we do not have the opportunity to simply buy our way out of this problem. We don't have the resources to go buy 60,000 or 70,000 tanks to match the Russian inventory or the equal number of artillery pieces. We also don't have the resources to put the required number of men into the field.

So we have to seek another way out, and we have over these past several decades sought that in qualitatively superior weapons. As I see it, that is the only alternative for the future. We will have to cope with the problem of maintaining our conventional strength with quality. We cannot do it with quantity.

Now, by quality, we can simply mean an improvement in the parameters of conventional weapon systems, the ones that we know about today, the tactical air, the tanks and all the rest, or we can mean by that dramatically new classes of systems.

Now, the history of warfare back to classical times, and I would recommend to you this book recently published, "Technology and War", by Van Creveld, which covers the period from classical periods through the Middle Ages to the present time. What histories like this, and there are others, indicate is that technology through that period of time has led to an evolution in warfare, new kinds of systems replacing old kinds of systems, and you can just recite such a change in evolution in the form of naval warfare, in classical times the galley with ramming was the prevalent weapon, in the Middle Ages naval warfare turned to sailing ships with broad sides of cannons, in the period between 1850 and World War II it was the battle ship with rifled weapons, and after World War II naval warfare turned to naval aviation, longer-range weapons.

What does that tell us? It tells us there is an evolution in weapons and the country that has the better weapons wins. if you put a

battle ship against a sailing ship with smooth bore cannon, the wooden sailing ship will lose for sure. If you put a carrier with its aviation against a battle ship, the battle ship loses. Each time a new evolution comes in, that gives a significant new capability.

Now, the R&D programs that your committee supervises are the key to the future, to the not only qualitative improvements, but the dramatic new classes of systems which have, therefore, the potential to maintain the superiority in conventional weapons and to keep our ability to cope with warfare in that area ahead of our enemies.

Weakness in the R&D program, on the other hand, will allow that superiority to slip away, and there is some evidence that it is slipping away if one looks at the lead that we have over the Soviets in various weapon systems, they are catching up. They now have look-down shoot-down fighters, they have AWACS. These are things only we had a way back. If we stand back, pretty soon they will have the quality we have, and we will no longer have an advantage. They will have the numbers. We will be in a very bad position.

There are dramatic possibilities available, and we see them in recent years, and I will give you a few examples. One of them is Stealth aircraft and missiles. The advent of those devices has rendered obsolete practically all of the air defense system investments made by the Soviets. It has just swept aside perhaps $100 billion to $200 billion worth of investment. Our investments in those systems I believe can be made for less than the $100 billion or $200 billion. We can come out ahead.

An example of something which we do not yet have but which would be a dramatic change would be the ability to attack armored forces from a distance with high precision weapons, outside the range of the artillery and the tank weapons, attack from 100, to 200 kilometers away. If one could do that, the armored forces as they now exist, the 60,000-70,000 tanks and all the artillery that goes with them, those would be weapons that would be like battle ships, obsolete in the face of weaponry like that.

There is another example in submarines, this is a qualitative improvement. As you are probably well aware, the changes in the noise levels of submarines have been significant in the downward direction in recent years and each advance in that area obsoletes the older submarines that are noisier. Those older submarines are at risk in the face of these dramatic improvements. I might say we have made improvements, but so have the Soviets. We have a race there and we have to stay ahead.

Now, in looking at the strategic sense of R&D investments, I think you have to look for the possibility of these significant dramatic changes into new classes of weapon systems as well as improvements in the conventional ones, but it is the dramatic change that you have to look for because that is what will change history, and that is what did change history for 3,000 years, each advance making an enormous difference in the outcome of various conflicts.

Now, in the few minutes left, I would like to talk a little bit about research management. I think, as Charlie Herzfeld has said, that the process has become mired down, it is over-centralized,

there are too many layers, it is micromanaged, the programs are cut into little tiny pieces and managed from too far up.

The military operators have become separated from the R&D efforts. Characteristic of the period Charlie was talking about, the golden age of World War II and just after, was a very classic period where the operators worked with the R&D developers, hand and glove. That is not the case today. There is a large separation.

In the U.S. industry today there has been a transformation in the way they operate. I am speaking about the commercial sector now. In order to meet the foreign competition, they have closely fused together the R&D, the manufacturing and the marketing, i.e., the military user in the case of the DOD, into teams that work rapidly to produce product to bring it to market. The DOD has lost that process. In World War II, a weapon system could be produced from concept to field in 2 years. That was done at the Radiation Laboratory at MIT repeatedly with various systems. Today it is between 10 and 20 years to do the same thing. Often what gets into the field doesn't do the job because the users have lost contact with what is being done.

Finally, I would like to make a few comments again following Charlie's on the personnel in the Government. I have observed a steady and dangerous decline in the quality of those people over 4 decades that I have been watching them. This is basically due to Government personnel practices, the salary scales and the lack of adequate research facilities and responsive procurement systems so that these people can buy the equipment to do their R&D.

My laboratory in some sense is in competition with some of these Government laboratories. I feel very badly about the way that people in those laboratories are being treated. They do not have adequate support in terms of personnel working under them, technicians and so forth. They don't have adequate facilities. It takes a year to buy simple technical equipment to support their R&D programs.

Mr. DICKINSON. Excuse me. Do you feel badly about people——

Mr. MORROW. In the Government laboratories. The laboratory at MIT operates as an industrial laboratory in terms of salary practices, procurement and all the rest, although we follow the regulations, the Government procurement regulations.

I know, for instance, that the offering salaries for new Ph.Ds by the Government are insufficient to get any new Ph.Ds, none. None can be hired. We fight it out for the so-called gun-slingers, the very very bright smart ones that AT&T and IBM go after and we get a few. For upper level administrators there is a similar problem. I support what Charlie said about that. There is a serious, serious decline in what you are able to attract into those very important positions at high levels in the Executive.

A great deal can be done by subcontracting the research out to universities and industry, but you still have to have responsible members of the Government supervising that work, and it is those people that you are having trouble maintaining and hiring and keeping today. I think this needs immediate attention. The pay raise, unfortunately, impacts it or the lack of a pay raise. But this is an issue which could affect the productivity of the DOD investment in R&D perhaps more than all the decisions you might make

in where to put the money, that one matter of good, responsible people to administer it.

Let me sum up with the following points then. The ability of the U.S. to deter, and if necessary win, conventional conflicts is critically dependent upon superiority in the weapons, not on quantities, we couldn't afford that. Such a capability may be extremely important in preventing an escalation to nuclear war, and it is the likely thing the country has to face, that conventional conflict is coming down the road to the United States. I don't know how far away it is, I don't know how large it is, but I would be willing to bet within 10 years we are into something, I don't know what.

A well focused R&D program can give us the advantage that we need under those circumstances. The current process for managing that R&D program is seriously flawed. There are excessive layers of micromanagement, and there is a lack of connection between the R&D and operators that are going to use that equipment.

Finally, to repeat again, there has been a serious decline in the quality of the people that you can attract and maintain in the Government to supervise R&D, and that lack of quality has a direct impact on what you are able to get in the way of response out of those R&D investments.

All in all, I think you have a significant responsibility, and you have some serious problems to address, you and the Executive, to turn this around because if we keep on going down the trail we have been going for four decades, in another decade or so we will not have superiority in weapons. We will be comparable with or worse off quite possibly.

Thank you, Mr. Chairman.

## Prepared Statement of Walter E. Morrow, Jr.

Mr. Chairman and Members of the House Armed Services Subcommittee:

My name is Walter E. Morrow, Jr.. I am Director of the MIT Lincoln Laboratory and a Professor of Electrical Engineering and Computer Science at that Institute.

You have heard Dr. Herzfeld make a strong case for the importance of the DoD Research and Development Program in maintaining the national security of the United States as well as his concern about the declining DoD investment in this area. He has also spoken of the need for reform of the management of those R&D programs. I full support these views of Dr. Herzfeld.

Prof. Carnesale has, in turn, discussed his views on the important issue of strategic nuclear systems and their impact on national security. The future direction of U.S. Strategic programs has, of course, a strong influence on the objectives of the DoD Research and Development Program.

I would now like to spend a few minutes discussing a somewhat different focus, namely, the nation's conventional or non-nuclear forces and the importance of DoD R&D investments in maintaining the capability of those forces. Finally, I would like to finish by presenting my thoughts on the management and execution of DoD R&D programs.

Over the past 40 years, countless conventional conflicts, both small and large, have occurred throughout the world. There is no reason for us to expect that the future will be any different. The U.S. has become involved in several of these conflicts, either directly or indirectly, and it may well find itself involved in such conflicts in the future.

Additionally, the U.S. has supported our allies with large overseas' conventional forces; supplementing these conventional forces are nuclear weapons.. Many have been concerned that, in the event of an attack on our allies, a rapid nuclear escalation could occur due to our conventional forces being overrun. There has been, therefore, a compelling interest expressed by Congress and others in strengthening our conventional forces to prevent such an outcome.

Now it is unlikely that we have the financial resources to simply increase the <u>quantities</u> of the currently fielded

conventional weapons as a means of strengthening our overseas' conventional forces. Besides, the increased numbers of personnel to man them would likely be politically unacceptable. We will have to find a different means for strengthening those forces, namely, providing them with qualitatively superior weapons which can place at risk the large investments of our opponents.

Any reading of history indicates the decisive impact of introducing technically superior weapons. While many other factors, such as morale, training, and tactics, are important in conventional warfare, the central role of technically superior weapons is evident.

The nation's research and development efforts, both in the Department of Defense and in the civil sector are the foundation upon which our weapon superiority rests. Given that, a strong DoD Research and Development program is critical. The question remains of how should we focus that program to obtain maximum leverage and how should we manage the research to achieve the best results.

In thinking about the direction of future research and development programs, attention should be paid to possibilities for significantly altering the balance between current

conventional forces by focusing on developments which can obsolete our opponents' military weapon systems.

As examples of such new directions, the following are instructive:

A. Current and future designs of stealth aircraft and missiles can render obsolete large investments in our opponents' air defense systems.

B. Systems capable of locating and attacking enemy-armored forces with high-precision long-range weapons have the potential to radically alter land warfare.

C. The advent of ultra quiet submarines can put at risk noisier submarine forces.

The research focus issue, then, is a matter of identifying technical opportunities for radically altering conventional warfare to our advantage and then identifying the underlying

critical research and necessary technology. I believe that success in this process requires a much closer interaction between our operational forces and those in the research and development community than is currently the case.

Turning now to the issue of research management, I believe the current management process has, in many ways, become mired down in an over-centralized, multilayered, micro-management which isolates the military operators from the research and development efforts. I would note that the current system for managing DoD research and development is completely at variance with the current practice in U.S. industry as it reorganizes to cope with foreign competition.

In U.S. industry today, as well as in successful foreign industry, there is an extremely close coupling between research, development, manufacturing and the market place. If the U.S. is to maximize the effectiveness of its DoD research, it needs to emulate U.S. and foreign industry by greatly modifying its current system to bring the military users much closer to the research, development and manufacturing of weapon systems.

Finally, I would like to finish with some comments on the DoD's Research and Development establishment. It has been my observation that the ability of the DoD to attract, retain, and

support research and development personnel has steadily and dangerously declined over the past four decades. Many others concur with me in observing this decline. At the heart of this decline are: government personnel practices, salary scales, and the lack of adequate research facilities and responsive equipment procurement systems.

It has been said that DoD can avoid this problem by obtaining its research from universities and industries. That view fails to address the critical problem of competent government employees to manage and direct that research and development. There is also the issue of the in-house government and research workers' effectiveness because of flawed personnel practices and lack of support facilities. The issue of attracting high quality personnel needs immediate attention by the Congress and the Executive Branch if DoD's R&D program is to bear fruit in improved capabilities for our armed forces.

Let me sum up with the following points:

1. The ability of the U.S. to deter and, if necessary, win conventional conflicts is critically dependent on technically superior weapons. Such a capability may be important

in preventing an escalation to nuclear warfare.

2. A strong well focused DoD Research and Development program is fundamental to the development of new weapons which can give the U.S. superiority in conventional conflicts.

3. The current process for managing DoD research and development is seriously impeded by excessive layers of micro-management and a lack of close connection between the R&D and the military operators.

4. Finally, a serious decline in the quality of government research and development managers and workers has occurred because of government personnel and procurement practices.

Mr. DELLUMS. I thank the gentleman for his opening remarks.

The chair will recognize the members in order of their entry into the hearing room, and we will begin with the gentleman from California, Mr. Hunter, for such time as the gentleman may consume.

Mr. HUNTER. Thank you, Mr. Chairman.

I just have a very brief question. Very interesting statements by all the gentlemen. Dr. Carnesale, I noted some feeling on your part that perhaps the President was riding the wrong horse on SDI at least that was my understanding. You mentioned that in history there were few military leaders who have responded to an increased defense by weakening their offense. There have been several leaders who have done this, particularly the cavalry leaders confronted with the advent of the machine gun. They didn't order more horses, and they didn't order Shetlands or faster horses, they basically realized they were going to have to change the situation.

I think that deterrence can be established in several ways. One, by having an overwhelming reactive capability or a strike capability, but also by having a big enough and strong enough shield that the antagonist is not able to do what he wants to do—bring the war to a successful conclusion. In that light, it would seem that SDI has some value, at least the pursuit of SDI.

I noticed Mr. Herzfeld made a statement early on concerning the number of so-called experts talking about the trillions that it would cost to put an effective SDI up. Some of the technical problems have been solved or are on their way to being solved, and it looked to me like there was a movement among those politically opposed to SDI to assert broad technical statements of impossibility into the argument in an attempt to keep the program from ever being started.

I am reminded that a dollar today buys four times the computer power it did in 1962, something we couldn't have imagined at that time. Could you clarify your position on SDI? That is what I understood from your statement. I hope I didn't misconstrue it.

Mr. CARNESALE. Yes, I would be happy to. SDI would satisfy my criteria for an active research and development program. First, you want to avoid technological surprise. Since we know that the Soviets have an active ballistic missile defense R&D program, this would be one argument for a R&D program.

Second, do you want to be able to develop counter-measures. This is something the United States has not enough of in recent years and was almost phased out by SDIO, which focused on advanced technologies and not enough on incremental technological change. This is the second strong reason for doing research on strategic defenses. Third, there might be something there.

I am in favor of an active SDI research and development program. In 1983 I wrote an article that said over the next 5 years the U.S. should spend about $15 billion. not $26 billion, which is what the President had in mind. The Congress, in its wisdom, chose to spend my number.

But let me get back to your point about giving up the horses in response to the machine gun. If the technology of the first or second generation strategic defense is so extraordinarily effective that it makes ballistic missiles essentially obsolete, I would agree with you. No such technologies are insight. That is not the same as

saying it is impossible for all time. But I believe that the notion that a likely result of this research program is a highly effective ballistic missile defense, one indeed so effective it would make nuclear weapons or ballistic missiles impotent and obsolete as the basis for public expectations or for making public policy should not serve. There are good reasons for a R&D program, but not to meet those expectations.

Mr. HERZFELD. Let me address your question, Mr. Hunter.

I think it is a very important one incidentally, and I would get into perhaps a slight argument with my colleague from Harvard.

Parenthetically, not everybody on the committee may be aware, but I ran the U.S. equivalent of the SDI program through most of the 1960s, and have been close to the issues ever since, and let me assure the committee that none of these arguments are new, we have been through it for 30 years, I must say, inconclusively, as the evidence shows.

The real problems with ballistic missile defense are the following: There are excessive expectations in many places, and parenthetically I think what the President meant probably was a good idea to say, but I wish he had been more explicit about it, namely that his hope of making these ballistic missiles impotent and obsolete was not likely to be met in his lifetime or mine or even rather young people. It is a long, hard road, but worth trying.

If you have a long-range problem, you have the option of waiting until later or starting immediately. I have no problem starting immediately. So much for the R&D and I agree with professor Carnesale, an R&D program is called for.

The real hard arguments this year and last year were about early deployment earlier than originally envisioned. There I must say I am very much in favor of that. I don't think this was terribly well explained though.

What is at issue is something like the following: Suppose we do take seriously the notion of a Soviet ballistic missile attack on the United States in a surprise mode or nearly surprise mode? You ask yourselves then, what is it they would attack first, since they are not likely to be able to have everything hit on target at exactly the same instance? What are they likely to attack first? If you think about that seriously, and serious people have done this, it is not my thought alone, the answer comes through that the most important thing to attack is the American Command and Control structure because the more damage that can be done to the communications from the President to the forces, the less retaliation there will be. So it is clearly in the interest of any serious attacker to try and impede that communication as much as possible.

Then you take a look at how does that work in detail? How many people are involved in the chain? How many places? Where are they? How long does it take to get them fully alerted and do their thing? The answers are not terribly comforting. In an open meeting, I don't think it would be appropriate to go into a lot of detail, though I am sure you can get expert discussion of the details in closed session, and perhaps you may want to do that to understand this very important topic in a more rich way—but the bottom line is it doesn't take very many weapons on the United

States with total surprise to make an awful mess out of this command control chain.

Now, a lot has been done to make it virtually impossible to destroy the chain in this way. But there is still a risk. Of course, ballistic missiles are not the only way you would go about doing this. There are all kinds of other attacks that would have to occur simultaneously. But the point is that even a rather modest ballistic missile defense system would make the kind of attack I described much less certain to succeed. It would make that attack much more risky and an attack planner would have to figure that he might have to plan to use hundreds of weapons rather than tens of weapons for this objective alone. That is a quite different kind of attack in size and in scope.

Is that worth some significant costs for a SDI system? I think yes, but I don't think it is the most urgent thing to do. When it looked like we would be able to get some more increases in the defense budget, 5 years ago, 4 years ago, I thought it was a worthwhile thing to try. Now when there is a strong consensus there will be no or only very small real increases for some time to come, I think there are more urgent things to do, and I would say we have to revert back to R&D only mode.

But I think the idea has not gotten a fair shake in terms of what it was all about. The auxiliary benefits, namely you cut out all the third country attacks and so on, that is also useful to do.

How much is that worth? Well, that again depends on the budget situation, and maybe that isn't worth enough right now. It is a complicated question.

Mr. MORROW. I would like to make a few comments also in response to your question. Like Charlie, I have been involved with this since a long time ago, or at least since the Laboratory has been involved, since 1958, as a matter of fact. That makes it a long time at this point—30 years. What I observed over the years is a long-term effort on a very difficult problem where in the early years it looked much more hopeless than it does at this point. In other words, what I am saying, very significant progress has been made.

After 30 years of effort, particularly the intense effort of the last 5 years, I can see real possibilities ahead. These are not ones that you would rush out and deploy tomorrow, next year or even the year after. But we are getting to the point where it is just possible we may have the machine gun, not of the kind that you read about in the press in space, but a different kind.

That is about all I want to say at this point. The people are busy at work, and I think things are very promising at this point. It might be 10 years or more before you decide maybe it was worthwhile, and I agree with Charlie, this is not something you probably want to do at this point, considering the problems facing the country, that is you don't want to rush out and deploy with the technology we have right now.

But I think things have moved a long, long way in these three decades, a great deal in the last 5 years, and there is real hope on the horizon.

Thank you.

Mr. DELLUMS. The time of the gentleman has expired. The gentleman from Florida, Mr. Bennett, is now recognized for such time as he may consume.

**STATEMENT OF HON. CHARLES E. BENNETT, A REPRESENTATIVE FROM FLORIDA**

Mr. BENNETT. Thank you very much.

I have appreciated the fine comments we have had here. Last year I chaired a group that heard testimony from former Secretaries of Defense, General Scowcroft and others about SDI, and I am a person who accords with what all of you have said. The research for SDI should be robust; it should be substantial; it should be carefully done; and, it should be in the proper amount. The real question, I believe, is the proper amount.

The testimony we had last year had some people saying $1 billion was enough. Others said $2 billion. I can't remember anybody saying over $3 billion. It seems to me that the country would be well served if we arrived at a figure and stopped trying to say people who are critical of throwing money at SDI are less than loyal or people who feel like it ought to go ahead into procurement immediately are dumb.

The truth of the matter is we have made progress, and it has been referred to as sort of a revelation. People don't talk about it very much. I was on the committee when we were talking about this long before Mr. Reagan was elected president, and many billions of dollars were spent on it prior to him becoming President.

Much progress has been made. As a matter of fact, the Aegis system today is part of this program. In other words, it is a spinoff, you might say. It is, in effect, a very good weapon for the Navy. So it has not been a loss. It has been a very thoughtful good procedure.

The question is: Can we come to a figure that would be a good figure at this time of carefulness with regard to spending? I, myself, don't think it ought to be more than $3 billion, but people could argue about it. I would like to see us come to some figure and stop pointing fingers at each other.

I would also like to give you one humble experience illustration that I actually lived through.

I was an infantry soldier in World War II in the Pacific and on occasion I would be relatively alone. I once approached a Nepa hut where I knew there were Japanese soldiers inside, and I emptied my entire carbine into that Nepa hut. On the other hand, I would go to a place where one Japanese soldier might be dug into the rock, and I would never approach that alone. I would at least want a squad, hopefully 20 or 30 people.

What does that tell you? Well, it tells you until SDI becomes perfect, and no one anticipates it is going to be perfect in the foreseeable future, to stop every round coming through, the obvious answer is to have more rounds. So as we get a more perfect SDI, we can expect the opposition to have more ICBMs.

What does that tell you? Well, suppose SDI was 90 percent effective today, which of course it is not, that would be 10,000 rounds pointed at us now from Russia, which would leave 1,000 rounds

that would be able to get through. It would mean we could wipe out Jacksonville, FL, my home town, and every city larger than Jacksonville: New York, San Franciso, and so forth, and we would still have 980 rounds or more left of the size of Hiroshima and Nagasaki. What that could do to this country is pretty ominous.

I listened to what Cap Weinberger said when President Reagan asked him before he came out with SDI, asked him about the ominous threat of the Russians having perfected ABM pretty well around Moscow, and suppose they would apply that throughout the country? Weinberger said, it is simple, all we would do is increase the number of ICBMs. That would easily answer it.

Then a year or so later, the President announced this program and called it SDI, and Weinberger then didn't think so much about what he had said previously, as I understand it.

Anyway, I think we ought to get down to real things. The real thing is, expressed on page six of Dr. Morrow's statement, the ability of the United States to deter and necessarily win conventional conflict is dependent on technically superior weapons. That is true. We are spending billions on this thing, which is going to stimulate the Russians to produce more ICBMs than less, and not spending enough on conventional weapons. What we are doing, if we go for excessive amounts in SDI, we are starving the chances of our country to really win the kind of war that is likely to occur.

It isn't a question of loyalty or disloyalty, it is a question of common sense. What is likely to occur—in view of President Reagan saying nobody can win a conventional war, in view of the fact we all know there are enough LLBMs under the sea to wipe out Russia after they wiped us out—it is just logical to think it is no longer very credible we are protected by a deterrent shield of nuclear weapons. It is just not there.

Now, when that will seep in and lack of credibility occurs, I don't know. I am sure it can't be far off. So in the meantime, we ought to try to strengthen our conventional strength so we could win a war in Europe instead of being faced, as we are now, with 6 or 9 days of ammunition, and conventional weaponry.

How would you get the United States and all its allies together in 3 to 5 days, or even 2 weeks, to decide whether they are going to use a nuclear weapon? So we must have nuclear deterrence. We cannot evade having it.

We should go forward with research and SDI, and it should be a thorough and robust research. We should stop pointing fingers at each other as to whether we were loyal or disloyal and look at the realities of it. The real challenge to America today is an appeal to conventional weaponry. We must get weapons to knock out tanks on the other side. We must get adequate weapons to win a war in Europe, which we can't at the present time do. That is the truth.

Instead of just supporting SDI because it is an attractive thing and great vision, we have to say go ahead with the research. We have to say let's go ahead with some of the conventional things that we need to do, both in the quantity and in quality. I would like to extend my remarks at this point in the record.

PREPARED STATEMENT OF HON. CHARLES E. BENNETT

Mr. Chairman, today's hearing is on long-term R&D strategy. In my opinion, the greatest long-term danger to a sound military research program is the continued growth of the SDI program.

First, SDI has grown quickly as a slice of the total DOD funding pie for all R&D.

In fiscal year 1984, the whole SDI program was equivalent to 3.7 percent of all DOD R&D funding for all services.

In the current fiscal year (1989), SDI has grown to about 10 percent of DOD R&D.

If Congress approves the Reagan budget request for SDI, the program will grow to about 14 percent of defense R&D in fiscal year 1990 and to almost 17 percent of defense R&D in fiscal year 1991.

Since total funding for defense R&D is not going to grow much in the future, that means the extra funding for SDI will have to be cut out of other important programs.

Second, it is clear that rapid SDI funding growth has already hurt our conventional forces. The House and Senate Armed Services Committees described this trend in 1986 in the conference report. I quote the committees' language:

"Research and development on basic new technology and on technology for conventional warfare has suffered greatly in recent years: in 1981 over 16 percent of RDT&E funds were invested in the defense technology base, but in the fiscal year 1987 budget request, only 8.7 percent was allocated to the technology base. In real terms, the technology based funding has declined every year since fiscal year 1983. The sharpest decrease coincides precisely with the buildup of the SDI program. Indeed, the funding level proposed for SDI next year will be larger than the entire research and development budget for the Department of the Army." (House and Senate Armed Services Committees, Conference Report on H.R. 4428, the fiscal year 1987 Defense Authorization Act, p. 451):

In fact, the Reagan budget request for fiscal year 1990 would give more dollars to SDI research than to the whole R&D budget for the whole Army. In fiscal year 1990, SDI would get $5.9 and the Army would get $5.6 billion. For the following year, the Reagan budget proposes to give SDI about $7 billion and the Army about $5.9 billion.

I think we need to keep these figures in mind as we listen to witnesses tell us that our defense R&D program needs more support.

Thank you.

Mr. DELLUMS. I thank the gentleman. The chair might indicate we will have ample opportunity to discuss SDI. I thought today we would take the opportunity to try to think long term, get beyond the confines of a particular weapon system. If any of the gentlemen would like to respond; if not, the chair would yield to Mr. Dickinson for such time as he may consume.

Mr. DICKINSON. Thank you, Mr. Chairman.

Gentlemen, I have listened to your statements with interest. I had no opportunity to read your statements in advance. I see nothing to take you to task about. I think in the main, I agree with most everything you have said.

One of the problems you alluded to but did not offer a solution for was the micromanagement, which we acknowledge as a fact. Speaking as a Member of the Congress involved from time to time in micromanagement, I would like to say that this is not an area I feel comfortable in. We as Members of Congress have seldom had the technical expertise to make some of the decisions we are called on. We make political decisions, we do that all the time. But the technical decisions have come very, very tough to us. and we have to rely on staff.

When you look at the staff that we have, I think we have 44 on our professional staff now doing battle with everybody in the Pen-

tagon, the appropriators, and the Senators. It is a pretty tough battle to make these decisions.

I would be curious if you have any suggestions as to what we could do, and especially Dr. Morrow, your comments. I don't know what we can do to improve the system. Let me give you an example that we can all readily appreciate, speaking of micromanagement.

Lockheed, their so-called skunk works, built a SR–71, which is a truly phenomenal airplane, and they have a truly phenomenal guy in charge of the program, Kelly Johnson. This was some 25 years ago, and he said, "You want capability? Give me the number and get out of the way. I will do the best I can. I will do the job, and I will give you an accounting when we are finished, and I will give you a product."

He did—in a phenomenally short time. I think it was around 3 years, as I recall. It takes us 15 years on the average now to get any sort of program through.

So for that reason we drifted into the black world, and so many of these programs where we are not supposed to look over the shoulders so much and make them account for——

Mr. DELLUMS. The special access world?

Mr. DICKINSON. I don't find black offensive, Mr. Chairman.

Mr. DELLUMS. I just have problems criticizing black programs, so we can call it special access.

Mr. DICKINSON. I was out at the skunk works recently, I believe it was in January, and we have imposed so many new rules and regulations and restrictions on all Government contractors, they had had 16 different audits in the month of January alone. Sixteen different audits, 1 month. We have 11 more months to go yet.

So they have a whole section set aside just for Government auditors to come in. This is one company. Of course, it helps unemployment, I am sure. When we had the waste fraud, abuse scandals and Ill Winds exposed a year or so ago, so many people came in and said, "We need to hire more auditors, we need to have more people looking over the shoulders and so forth. Pass more laws."

I don't think that is the problem or the solution. You are right, there has been a change in attitude. An adversarial attitude between industry and DOD has developed. I really don't know what the answer is except to say in our own defense, speaking of micromanagement, there have been many major programs that we had to get into in the Congress because of a failure on the part of the Department of Defense. There have been many programs sent over here that we had to kill, that the military, DOD, would not kill.

Then the battle with the tanks is one example, the roll-on missile is another example. The Navy skip bomb, the Copperhead is another and we can go on. So we are forced into the position, I mean this truly, reluctantly, of having to get in and micromanage because of the failure on the part of whoever they be in the military and in the Department of Defense to properly and successfully manage their own affairs.

So I am not asking you to fill the record today, but if you have any comments to come back briefly, I would appreciate them, if you have any follow-on thoughts you feel would be helpful to the committee. We don't want to micromanage, but we are forced into

it due to the failure on the part of those who have the initial responsibility, and perhaps it is forced on them by us putting so many layers of requirements and restrictions and everything else that we have put on them by law. Every time something goes wrong we have to pass another law. That is not a question but a resounding statement. I would appreciate any response to these comments.

Mr. MORROW. Thank you for your comments in this area. Micromanagement is not all on the side of Congress, it exists over on the Executive side as well. The multilayered was another term that I used with micromanagement, and the multilayered may be the reason that you are into the micromanagement business.

If you look at the skunk works operation, it was characterized by very few layers, like one layer. You went to Kelly Johnson and said, "Get me this." At the present time, if you will look at the way things are organized, in spite of the Packard Commission and the laws that came in afterwards, there is still a very large number of review levels and people in authority before you get to the OSD level. How many levels——

Mr. DICKINSON. Let me interrupt you just to give applause where it is due. Kelly Johnson was in charge of the system to build the Blackbird. It is 25 years old at least now. It is still state of the art. Nobody has ever yet built a higher performance aircraft than that bird. It flew from New York to London in 2 hours 48 minutes, as I recall. If you fired a 30 odd six rifle at the same time, the bullet maintains its velocity from here to London, the plane would have beat it there by 20 minutes. So that is what can be done.

Because of success, I think we have tried to proliferate and haven't always been successful. Thank you, go ahead.

Mr. MORROW. The multiple layers, I think, lead to lack of perception and oversight at the upper levels of the layer. Something is lost at each layer in terms of reality. If you get three, four, five, six layers—I remember one DOE project that had 20 layers in it. By the time you get through that many layers, reality has been lost. When you lose reality, you end up with programs that may be failing, but the upper levels don't know it.

Congress may know it by some other routes running below the layers.

Mr. DICKINSON. Can't see defeat, right?

Mr. MORROW. Right. There is a serious problem in the way things are organized over on the Executive side in terms of pursuit of the R&D programs, too many layers, too many staffs, too much review. Less layers would lead to better knowledge at the upper levels, and then people would know when to cancel and when not to cancel, when to go ahead and when not to go ahead. Then that would lead then, I think, to less of the micromanagement.

The micromanagement takes form now of a large number of lines in the budget, as you know, and I feel they are excessive. There are huge numbers of them. If you will look back historically, you will find many fewer. An example would be the Polaris program. If you go back and count the number of lines that appeared in the congressional budget, it would be very very few indeed. If you were to take that program today and organize it in the current style, God knows how many lines would be produced. There would

be one for the warhead, one for the missile, and one for the submarine, and one for the engines and one for command and control, so forth and so on. You would have probably dozens of them.

The real tragedy is that if the funding were to fail in any one of those lines for that program, the whole program would fail. So it is a serious problem when things get fragmented in that fashion. There needs to be consolidation. People over on the executive side need to be told the Congress is giving you this bundle of money, maybe it is for ADI (Air Defense Initiative) or something like that, you organize how that money is to be used. We are not going to tell you how to slice it up, and you come back and tell us what you have done with that money. You know what the objective is, and you will be judged by your accomplishments. I think that can be done. Historically it was done. It can be done again if one wants to.

If you are going to get the maximum out of the money you are putting in now, and it is a lot of money, it is billions and billions and billions in R&D, you got to go back to the procedures that we used 20–30 years ago, the kinds of procedures that got us the SR–70, the Polaris and a number of other very good systems.

Mr. HERZFELD. If I might make a comment or two about your very suggestive and interesting question. I think there are a number of factors in play that are making more difficult to get out of this trap we are in. For one thing, I think we have gotten into a mode, all of us, where we are trying to do too many things with too little money. The defense budget is an enormous budget, but I think we are trying to do too many things with it.

As a consequence, almost every program start is very optimistic about the cost of the program. The first numbers that get written down anywhere, I think, are low and there aren't enough managers to say, "I don't believe it, I am going to double it before I let you go talk to my boss." As a consequence, what happens is that programs are presented that are not realistic, and that is a guarantee for failure, which then, of course, in turn causes more supervision and more oversight requests.

The second thing is there are too many line items per program, just as Mr. Morrow said. That has gotten out of hand. It is a structural thing that could be attacked again jointly by both sides of the aisle, I think both sides have to work on this to really make that work, but it can be done.

Another factor is, I think that we are seeing in some of the lack of responsiveness that you feel, lack of responsiveness from the DOD, the impact of the salary squeeze at the top.

Mr. DICKINSON. I am glad you brought that up, but go ahead.

Mr. HERZFELD. It works again on both sides of this room as well. Very specifically, as we were saying earlier, it is difficult to recruit really experienced managers into these few top slots who know enough, have enough judgment, enough experience that everyone can trust what they are saying.

A friend of mine just before he left the Pentagon did a study about what the different people were doing who were in the procurement chain. It turns out there are about 450,000 people in the whole country that somehow or other are involved in buying stuff for the DOD, and he had this broken down into some 12 job categories. It was interesting. I took this and just counted up the "watch-

ers" and the "doers", and there was one watcher for every two doers. Now that is too much. I think a 33 percent overhead would kill any business, 10 percent, well, yes, maybe. Actually 2 percent is more ideal. But 30? That is wrong. How are you going to change that? We have to change it.

Finally, I would like to make an appeal. We talked a lot about a few specific programs, and obviously you ladies and gentlemen must take a position on these programs through the year and to help shape the budget. But I feel that this particular subcommittee is sort of the Godfather and protector of one thing, it is the only protector in the system, and that is the R&D technology base, not the whole RTD&E account, which is a huge thing, but the R&D, the science, the technology, the advanced technology, that part of the package that makes sustainability in peace-time. That is what enables us to go on through peace, just as "beans and bullets" are the sustainability for war. You folks are the ones in charge of insuring that we have this sustainability for peace.

Mr. DICKINSON. Thank you for your statement. Thank you, Mr. Chairman.

Mr. DELLUMS. The gentleman yields back his time. The gentlewoman from Maryland, Mrs. Byron, is recognized for such time as she may consume.

Mrs. BYRON. Thank you, Mr. Chairman. No 5-minute rule?

Mr. DELLUMS. The gentlewoman has such time as she may consume.

Mrs. BYRON. Let me say I was very interested in Dr. Herzfeld's comments when he was talking about our national labs. One of the things that has described me for the last several years is the roller coaster nature with our cyclical budget cycle. How in the world can a national lab that is working under a handicap, as Mr. Morrow talked about, with all of the wickets and widgets they have to go through just to get equipment, deal with a budgetary cycle when we sit here and pump up programs with funding levels, you put together a very good team, and you get the team going deeply into research. A scientist doesn't like to have to look at the budget process on the outside, and now what we are doing is making our national labs be accounting firms and seeing what is going to be on the drawing boards, what they can afford and not afford. It is a wonder to me that we are able to attract the talent that we have.

What concerns me greatly is with the educational process that we have, the small number of slots in graduate programs and the stringent requirements that we have for our national labs in competition, whether we are going to be able to manage and be able to keep that type of a team together is very difficult. I think that is a point that this committee, looking down the road, is going to have to address, and it is one that has disturbed me very much over the—for the last few years.

Dr. Morrow, you mentioned military personnel in your presentation and the decline in quality. One of the things I have looked at and been pleased with over the last several years, is an increase in the capability of our military personnel and the increase in quality. Both quality and capability have dramatically increased, not decreased.

Obviously with that thought in mind, you obviously had some proposals which you would consider coping with those problems because we are looking in the outgrowth years today. What I have been looking at, Mr. Dellums has said in the past this subcommittee has the benefit of having four chairmen of subcommittees on it, and I chair the Personnel and Compensation Subcommittee, and I am pleased to say the quality we are getting in is so far superior to what we saw 10 years ago. So these new people that are coming into our process are going to be the ones that are 10, 15 years down the road we are going to look to as our leadership.

So when you mentioned military personnel declining in quality, it sort of rang bells.

Mr. MORROW. Just to comment, I was referring to the civilian laboratories, not——

Mrs. BYRON. Then we are on the same track. That is fine.

Mr. MORROW. I would agree with you on the new recruits coming into the military, the officers are very good people coming in. The thing you must watch, though, is to see how long they stay. Many of them are ROTC students from leading universities under commitments of 5 years, or whatever it is, 4 years. How many of those stay beyond the 5 years is a critical question.

Mrs. BYRON. What I think we have to look at, and this subcommittee is the one that is going to be the driving force on that, is whether we are going to have innovative programs, R&D challenges that they would not get in the civilian life, and whether those challenges are going to be there to make them say that this is a program that they want to have a long-term commitment with, and they are going to be able to be involved in something that is exciting and that is going to be very fruitful and to be able to look ahead, as we are doing today, for the 10 to 20-year spectrum and see.

Mr. Dickinson mentioned a program which I find one that is still an amazement to me, and that is the SR–71 program and how that was handled and the fact it is still competitive today, almost 25 years after its development.

Another issue I think we need to look at is the F–117 program, which was done in a special access program. I am a new member on the subcommittee. Mr. Chairman, I want you to notice I learn quickly, it is a special access program, and it is one that was designed, produced, procured, and operational when it was still in the special access category.

If we are going to lose all that capability, I find it is going to be very difficult for us to be competitive in, as they say, the real world of special access.

Could you touch on that a little bit?

Mr. MORROW. Well, we do have examples, and you mentioned one, of significant accomplishment recently, and I believe there are others. It is my impression, however, that the auditing and the multilayer management is creeping into those special access programs and that they do not have today the ability to do what they once did many years ago, in spite of the accomplishment of the recent accomplishments in that area. They, too, have fallen prey to the multilayers and all the rest of it, not to the extent of the so-

called secret level, non-special access programs, but they are endangered.

It hasn't happened yet—those programs have not yet gone the way of the dinosaurs, but they are in danger, there is no question about it.

Mrs. BYRON. I guess what you are saying, when we saw the commitment during the Kennedy years to go to the moon and we sent a message to our young people in school to beef up on your math, get your science degrees, go into engineering and there would be a job for you, what we are saying today is do the math and get your CPA, and you will find plenty of work ready for you now because everybody is going to need twice as many auditors as we have in the past.

Mr. HERZFELD. Exactly so.

Mrs. BYRON. I have one further——

Mr. HERZFELD. I wanted to make one remark, Mrs. Byron. I am very much in favor of the work you have been doing in personnel and I wanted to comment on something.

Part of the conventional wisdom now is to deplore how many science and engineering graduate students are not U.S. citizens. When I was a graduate student, I was not a U.S. citizen either. It may be more important to think about whether they will want to stay and to make that easier than it is perhaps now.

I think it is a chance to recruit talented energetic people across a different ocean than in my day. I am not sure we are doing all the things that might be done to encourage them.

Mr. MORROW. At the university, we see these large numbers of foreign students. At the same time, we see enormous impediments to them becoming citizens. They are the cream of the world.

We have attracted them here. We should change our immigration policies. The cream of the world built this country.

Mrs. BYRON. Dr. Herzfeld, you mentioned the computer technology. We have heard about computer viruses—I am computer illiterate, but there are new terms that come out on a regular basis and "computer virus" was a buzz word active a month or so ago.

Where are we today and where are we heading in the future on computer technology, if we are going to be inundated with those type of offshoots from extremely talented, very capable young whiz kids?

Mr. HERZFELD. A couple of things are certain. The hardware and software technologies will make great improvements in the next decade. That is almost guaranteed barring a great worldwide catastrophe, because the physics is there, we can do much more and the need is there.

Exactly how that will play out is an interesting game that we are trying to sort out, but the fact is that it will happen, I think, it is almost certain.

At the same time, it is clear that there are people who either for entertainment for themselves or because they wish some people no particular good are thinking hard about how to make trouble for such systems.

I believe that this is a battle that will go on forever just like all of these measures, countermeasure things. You can never go to bed some day and say, "OK, I have done it. I have put to rest all the

worries," but I am convinced that through sophisticated coding techniques, it will become possible to make it more difficult to do covert damage to these systems.

If we don't learn how to do this then large fractions of the infrastructure we have in the world in banking and communications is at risk to very serious mischief, and so there is lots of interest in thinking this through.

I wonder if——

Mr. MORROW. We had some experience with that virus at our laboratory. We have a large number of computer systems that operate at a variety of different classification levels, including special access.

The virus appeared. It caused some problems in some unclassified systems that are connected to the outside world, but got no further than those.

Those affected were only a few low-level systems of no real significance. The really powerful systems were all isolated from it and the special access systems were isolated with cryptographic gear which would defeat even the smartest generator of viruses.

So it is possible.

I would concur with what Dr. Herzfeld said. We will have to put together systems that are not vulnerable to this type of attack.

The danger to our banking system may be even worse than the danger to our defense system if such penetrations can happen.

Mrs. BYRON. Thank you, Mr. Chairman.

Dr. Carnesale, I have no questions for you today.

Mr. DELLUMS. The gentlewoman yields back her time.

The Chair yields to Mr. Kyl for such time as the gentleman may consume.

Mr. KYL. Thank you, Mr. Chairman.

First of all, I compliment you on this panel which all three of you gentlemen provided some very informative and provocative analysis.

Quickly in all three, Dr. Herzfeld, I would have like to have gotten a bit more to the item of micromanagement. I wanted to say that particularly paragraph 2 on page 7 of your written statement I particularly appreciated and wish some time we could get into a bit more detail.

Mr. Morrow, I appreciated the emphasis on competitive strategies and the need for more money for Government laboratories. I couldn't agree with you more on that.

Dr. Carnesale, I had a couple of questions that I wanted to ask you because you were the most theoretical.

I was reminded of a definition of an economist, but an economist, I was told, is someone who sees something working in practice and then wonders if it will work in theory.

To some extent, the analysis of what you do with these various systems kinds of reminded me of that definition.

For example, if we assume that the goal is stability and we have had 40 years of no cataclysmic war and the things you were talking about dealt with a cataclysmic event, not the conventional kind of wars and if we concur with the thesis that it depends on whose weapons you are talking about, ours or theirs and whether both sides have weapons.

If one side has mobile missiles, then is it necessary to achieve the goal that we discussed for the other side either to acquire a similar system or a defense that very capably deals with that mobile missile?

Mr. CARNESALE. While I am a Professor of Public Policy and Administration at Harvard's School of Government, my Ph.D. is in nuclear engineering.

I was on the U.S. delegation that negotiated the ABM Treaty and the SALT I agreement.

In terms of remarks about stability, the conclusion to be drawn is that stability, whether strategic stability or arms race stability, is extraordinarily robust. There is remarkably little you can do to screw it up, and we ought to keep it that way.

As for mobile ICBMs, we are quite fortunate. We only have a small fraction of our strategic force in ICBMs, roughly 20 percent.

The Soviets have a big problem as ICBMs become vulnerable. They have almost 70 percent of their strategic force in ICBMs, so comparing ICBMs on the two sides gives very little information about stability or anything else.

If the Soviets destroyed all of our ICBMs, we would have 80 percent of our strategic weapons left.

If we destroyed all of their ICBMs, we would have destroyed 70 percent of their force. They would have only 30 percent left, but even that is a lot.

So I feel stability is very robust. There is no way that any rational person on either side could imagine that after a strategic first-strike and a retaliation, his country would be better off than it was before.

So I do not believe that because the Soviets have mobile ICBMs we must ape them. We were quite fortunate in going to sea long before they did, and in having a much better air-based leg.

If we can deploy survivable ICBMs in a cost-effective way, we ought to do it to hedge against possible advances in Soviet anti-submarine warfare. That is the only good reason, but it is a very, very good reason for developing and deploying survivable ICBMs.

Mr. KYL. Getting back to my question about what the theory really tells us, I gather you are saying it doesn't necessarily tell us what to do in terms of directing our research into a potential development program if the other side has any particular weapon.

I was going to ask you some other examples, too, but I assume your answer would be the same. It doesn't necessarily tell you anything then.

Mr. CARNESALE. I think the gentlemen on the panel would agree we shouldn't try to duplicate the Soviet air defenses. You can't tell anything just in general. You can look at each program and decide whether it is in your interest or not, but there is no simple rule that says because the Soviets have some weapon system, we ought to have one, too. A simple rule like that will not work.

Mr. KYL. Is it not correct that if the other side has an effective weapon or an effective defense to achieve the goal of stability, you either need to know that you already have something that can deal with it or you should try to develop something that can deal with it. It may not be the same thing.

For example, if they have an offense, you may want to develop a defense rather than to develop an offense like it.

Maybe I missed your point totally, but I thought one of your points was that if stability is the goal, that you need to be able to deal in a similar way—not a similar way, but deal with a threat from the opposition in such a way that you enhance stability?

Mr. CARNESALE. I said that is the argument that is used nowadays as the rationale for virtually any system that anybody wants.

If you look at the current situation, let's agree for the moment that it is quite stable. You will notice that we can't deal with the Soviets' weapons and they can't deal with ours.

Nobody here knows how we are going to deal with the Soviet ICBMs. Nobody here knows how the Soviets will deal with our ICBMs. That has led to robust stability.

I want to keep it that way. I want to make sure that they can't deal with our missiles. That is one reason for maintaining R&D programs. It is not true that stability rises from an ability to deal with each other's weapons.

I would argue that stability stems from the fact that neither of us is able to deal with the other side's weapons so starting a nuclear war would be suicide.

Mr. KYL. Stability can relate to a way that you have countered the opposition——

Mr. CARNESALE. Sure. Stability stems from the fact that neither of us has been able to counter the oppositions' forces.

I am an American. My favorite world is one in which we could not destroy the Soviet Union and they could not destroy us. My least favorite is one where they could destroy us and we couldn't destroy them.

The world we are in is one where we can destroy each other. It is quite stable. I don't like it because it may fail because of irrational reasons.

Mr. KYL. Do you believe that if we could develop an effective strategic defense that it would enhance stability to deploy that defense?

Mr. CARNESALE. I suspect not, but I would be in favor of deploying it anyway if it did not undermine stability too much. If deterrence fails some day, an effective defense could reduce the damage to my nation.

Defense might make war a little more likely, but I would be prepared to pay that price because I don't want to depend upon Russian rationality forever to protect the United States.

Mr. KYL. I will make the assertion, and you can agree or not. Stability isn't necessarily the only goal here.

For example, and politics have as much to do with it or rationality as you pointed out as do weapon systems.

For example, it might be argued that the Germans and the French thought they had enough weapons both defensive and offensive to have a stable situation in 1939, but they got attacked anyway. So politics will play a large role in this.

To your point directly, there are other goals that research needs to be geared to and I would make this assertion and have all three of you comment.

One goal is to produce weapons of war that permit us to win if there is a war, one of the points you just made.

That fact, having weapons that permit us to win frequently creates deterrence depending upon what kind of weapons we are talking about.

That is also a goal that may or may not be achieved by achieving stability.

For example, Pat Brittania after World War II, stability existed in a sense, but it was stability because of predominance, not because of equality.

So my question is you are not equating here stability with equality, but rather stability through any one of a number of circumstances?

Mr. CARNESALE. That is right. You could achieve stability through overwhelming superiority on one side.

I talked about three classical objectives. The first was reducing the likelihood of war. Second was reducing the consequences of war should it occur—that is, to win and to have minimum damage to your homeland. The meaning of winning is unclear in the nuclear age.

Let me express what I think is the fundamental paradox of the nuclear age. The way we try to avoid nuclear war is to make sure it would be so horrible that no one in his or her right mind would start one. That has been our source of stability. The danger is that if a nuclear war should start perhaps for irrational reasons or by accident, it is likely to be as horrible as we designed it in our attempts to avoid it.

There is a fundamental tension between lowering the likelihood and reducing the consequences. We have lowered the likelihood by making the consequences high.

The third objective I talked about was reducing the cost of preparing for and deterring war.

The principal way I believe that you deter war is by making it clear to the adversary that he can't win. I prefer that we win, but given the arsenals on both sides, it requires a theological argument to determine what winning means. If 50 million Americans were left and 40 million Russians, would that mean we won?

Mr. KYL. More comments?

Mr. HERZFELD. Only one comment about the nature of the world we live in.

I agree with a great deal of what Professor Carnesale has said, but I do think I take a different road at a critical point.

I think it is not realistic to assume that once one nuclear weapon goes off anywhere, all of them everywhere have to go off, that if anything goes wrong, it is the ultimate catastrophe.

I think that is unreal in a number of important ways. I know of no military doctrine in the U.S. or in the Soviet Union or anyplace else that contemplates that kind of a war.

It is conceivable that one might slide into this by accident—certainly World War I was slid into by accident. But World War II was started by somebody who wanted to start it—that was very clear. So it is conceivable that a great nuclear war would be slid into by accident. I just really don't believe it.

I think nuclear weapons have made people very, very careful and very thoughtful and I think I agree with what Al Carnesale said on this. But I think we need to get one step more and say and even if something should go wrong, we should try to design ways of coping with that that do not involve total catastrophe—I mean that would reduce the likelihood of instruction of the human race.

I think that can be done. I think it can be done by thinking about how the early phases of such a war might look and what one might do about them. What I am much more concerned about is a different kind of a nuclear war, not the one that you two were talking about where we launch 10,000 warheads and to hell with it, if you will pardon my French—I am much more worried about a situation where somebody, and I don't think it will be the United States, says to himself and some people might call this a irrational choice, but I am not sure one could prove that—someone would say I bet I can get away with a small attack, small meaning 10 or 20 weapons, if I attack certain targets, for example, I avoid cities, I only concentrate on command and control. I hit the U.S. ports and the airfield, that reinforcements have to go from to go to Europe, and I bet I can do that with 10 or 20 weapons and then tell the Europeans and the Americans do you rally want to do anything about any of this?

You guys have lost, give up, we will manage Europe for you and let's stop. I don't know which President would have the inclination to order the full SIOP under those circumstances.

The reason that I personally am in favor of a modest deployment of an SDI system is because it would turn this kind of an attack into a pretty big attack if one really wanted to have it succeed.

It would raise that threshold from tens of weapons to hundreds of weapons and that would be a totally different kind of situation, I believe.

So I believe it is worthwhile, especially when you think about certain weapon systems, to look at some of the fine structure of how some of these events might happen.

I know it is a very respectable school of thought that this kind of analysis is hopeless, doomed from the start, encourages nuclear war, I understand that.

I don't agree with that particular view. I will only say one more sentence, as a counter example, think of attack with chemical weapons. It is a big problem you ladies and gentlemen will have to deal with in the course of your work.

Chemical weapons essentially are impossible to outlaw effectively. You can't verify with high reliability that nobody is making them. I think there is pretty near unanimity on this.

So what do we do? Give up? No. How can we threaten retaliation. Some people say with nuclear weapons. That is silly. That would unleash a nuclear war.

I don't think anyone would have the discipline to just use a few and hope everything stops.

What do we do? I don't know the answer. We will have to find a consensus that we can live with about that problem. It is a pretty awful thing to think about, but sometimes you have to think about these terrible early steps of what might be a catastrophe in order to cope with it at all.

Mr. KYL. If that is a strategic kind of attack, that is why we should support SDI.

Thank you, gentlemen.

Mr. DELLUMS. The time of the gentleman has expired. The Chair would like to indicate that I have thought about whether or not the Chair should begin the questioning. One advantage of that is that hopefully you establish a framework for the balance of the hearing, but then coming last affords you the opportunity of not having to compete with anyone for the time. It affords me the opportunity, if not to educate my colleagues, to further involve myself in the process of the committee educating itself, and the Chair can be educated in this process.

So I deeply appreciate the opportunity to address you gentlemen and have an exchange with you.

I would like to begin with Dr. Morrow and then I will go to Professor Carnesale and finally come to Dr. Herzfeld.

Dr. Morrow, I am operating as a new chair of this subcommittee and perhaps naively believe that this subcommittee has a very unique opportunity here—it seems to me even a—responsibility—to look into the future because there is no rationale for research and development until you contemplate the future. By its very definition, R&D is future oriented.

In the course of your remarks, you alluded to the development cycle of our military systems as I did in my opening remarks typically being 10 to 15 years.

You then hastened to follow on that at one point you recall that had been truncated to 2 years.

The question I would raise is that if we truncate our developmental process to 2 years going from basic research to a weapon system, does that not contradict long-term thinking, long-term planning because it seems to me that the extent to which you roll out a weapon system in that short period of time you are never about the business of thinking 10 or 20 years down the road. You are thinking short term. You are thinking about the threat assessment as you conceive it off the end of your nose and there are tremendous dynamics that drive forward with the weapon systems with no effort to think in the long term.

Does that not contradict long-term planning in order to truncate a development cycle into 2 years? Does that preclude us from thinking beyond the world we perceive today?

Mr. MORROW. The 2-year period that I referred to was during World War II.

At that point, the country had built up a fair pool of technology, not through investments by a Defense Department, but from the commercial sector.

We were faced with a very severe war, and a desire to end that was as quickly as possible.

There were enormous pressures to produce under those circumstances new classes of weapons which were perceived to be useful in ending that war quickly.

The atomic bomb was one example, microwave radar is another example, the B–29 long-range bombers is another example and those equipments were produced as quickly as they possibly could

be, the need could be seen and the technology was seized, whatever was available.

I agree that today we do not face those circumstances and we should look long term.

The planning should be one where we are looking 10, maybe 20 years out.

That does not argue, though, that we should indulge in development programs that have horizons that are beyond 10 years and the reason that I say that is the following: If you have programs that take that long to reach culmination, the technology that you end up deploying is antique—it is 10 years old.

There is some optimum that lies between the extreme that I mentioned, the 2 years and what we are experiencing today, say the Aegis system, it is being deployed 20 years after it started.

Where that optimum lies, I don't know, but it is probably nearer 5 years than 15 years, because the technology at least in the civil sector, and I hope also in the military sector, is moving along fairly quickly, and it would be a shame to produce a system that had antiquated equipment in it, because the process of getting through all the R&D and testing and production took you 15 years.

I agree, therefore, that the planning should look well out, but the implementation should be quicker than that time cycle.

We ought to be doing it somewhat faster, but not on a crash basis.

Mr. DELLUMS. Two follow ons in that regard. Should technology obsolescence be the only factor that we use to determine whether the efficacy of a 10 or 15 year lead time, as you said, that much lead time we may put antiquated and obsolete technology out there. But what about whether the threat assessment is antiquated? One thing that has been interesting and fascinating to me as I tried to diligently listen to these hearings, there is no concept, at least there has been no presentation of any idea as to the threat assessment.

The nature of the threat may change or your enemy may change. We talk about technology obsolescence in a vacuum but we live in a world that is real. In my humble opinion we ought to demand for objective threat assessments. In this committee this ought to be one place we are not talking about politically motivated threat assessments. This ought to be the place, given the nature of its business, R&D, that we ought to demand an objective threat assessment. Can the threat also be obsolete? My point on the side.

Mr. Gorbachev is a new reality, INF is a new reality. Withdrawing troops from Afghanistan is a new reality. Saying you will withdraw 500,000 troops from Europe is a new reality. Don't we also have to bring into consideration the machinations of other nations and other leaders as they begin to pursue a world not quite as violent and not quite as hostile? Can our threat assessment also not be obsolete?

Mr. MORROW. It certainly can. I think the big problem of the threat assessment is not so much obsolescence as gross uncertainty. When you talk about trying to project where things will be 10 years from now, 15 years from now, 20 years from now, you are dealing well beyond the realm of reasonable extrapolation from current trends.

You certainly are not dealing with the possible change in the political department such as you are discussing. Nor are you talking about what in the mathematical sense we would call second derivative changes.

We see a change in the new Gorbachev initiatives, what I mean by the second derivative is there could be a reversal of that due to misadventure in that country. So we could be looking 10 years out maybe at a reverse cycle. I think a far sounder way to proceed is to stand back and look at where we stand today in the way of conventional warfare and strategic warfare and ask ourselves the question: what could we do that would dramatically change the situation in our favor.

This is the competitive strategies. What would dramatically change the situation in our favor, how could we invest monies that would obtain a very significant advantage to us no matter how the politics of the situation went? We might this way be able to substitute, although I am fond of horses, we might be able to substitute machine guns for horses. I don't think that is a particularly good trade off.

But that kind of a thing. Could we substitute something in the place of large numbers of tanks? Could we substitute something that would make the genie of chemical warfare go away? I don't know what that might be but is there something that could turn that around some favorable way to us?

That is the kind of thing I think is what needs to be done. I am very doubtful about our abilities to do good threat assessment and good projections for the long term. I think you can predict yes the Gorbachev affair will continue for another 3 to 5 years probably. Beyond that, who knows? He has two possibilities: he may succeed and he may fail, and we have to think about what happens if he fails.

Mr. DELLUMS. Well, you also in those 3 or 4 to 5 years that you allowed to sit down around the table and intelligently negotiated arms control agreements that moves us away from arms escalation; is that not true?

Mr. MORROW. Yes.

Mr. DELLUMS. You also made a very interesting case for superiority in weapon capability. You alluded to the book that points out the history, the guy with the best weapons wins. Someone once said we developed the capacity to develop life with nuclear energy everything changed except the way we think. Professor Carnesale talked about who wins in a nuclear war if 40 million or 50 million people die. I come to it as a lay citizen. I don't think anybody wins in a nuclear war and I think there is intelligent and compelling advocacy for that particular point of view.

So how then do we continue to pursue this notion that the best weapon wins when if we unlearned the nature of this terror, the whole planet loses? At what point did rational and intelligent minds—again I underscore rationality, because if the world is unrational anything can happen and we are sitting here on borrowed time—if we introduce rationality into international relations, at what point do we decide the issue is no longer best weapon wins so that this notion of superiority begins to lose its power and its relevance because we now have a weapon that can destroy ourselves

and it seems to me that requires us to rethink any notion about the best weapon wins.

Mr. MORROW. There are all kinds of best weapons and the kind that I would prefer would not be ones that destroyed ourselves. As an example, this is farfetched, but suppose we could develop a weapon which would prevent ballistic missiles from being launched, not by destroying them but by causing their electrical circuits to not function at all? There is a weapon which is non-lethal to people, it is lethal only to the weapons and is not in a mass destruction weapon.

So there are ways one might come up with which finesse the validity issue but still gives you superiority, gives you control. This is probably wishful thinking, but I think given the danger from these weapons, the nuclear weapons, we need to think about that kind of direction, and the same thing would be true, I would say, in the conventional warfare area. Is there a way that we can just cool off one of those conflicts, stop it dead in its tracks without mass destruction? Because you can have mass destruction with conventional weapons just as you can with nuclear weapons.

If you look at the city of Tokyo in World War II after the conventional weapons finished working it over, and compared it with Hiroshima, there were more people dead in Tokyo, a larger area was burned to the ground and the loss was greater with conventional weapons.

It may not be true with hydrogen fusion weapons today but nevertheless I think conventional weapons represent a threat to life and property. If there is a way to cope with those, we should seek it and gain some superiority that way.

Mr. DELLUMS. You also, in your presentation, made a case for continuing to maintain technical superiority. In fact you alluded to the potential danger of slipping from the position of being ahead to being even, maybe to even falling behind. On its face that seems to be compelling but the question I would like to raise with you is: what is the danger of being even in the context of modern life, in the context of the reality of the extraordinary weapons that we have developed, does this notion of staying ahead really have intrinsic value, or as we evolve into the 1990's, has this notion of superiority lost its meaning in that equivalency or even being behind? Maybe that whole thing is illusory at this point certainly given some of the presentation of Professor Carnesale?

Mr. MORROW. I think the answer lies in a book like this. The answer in here and in other books is that if you fall behind in terms of technical capabilities, you fall behind in many other ways. You fall behind in terms of what we call national security, but it is couched in many other terms. Your economic situation, your position in the world, your ability to maintain freedom in your own country. The first example that is discussed in this particular book were the Greeks and the Romans and the particular weapon systems are discussed and what happened to the Greeks is very, very clear at the hands of the Romans.

I think that it is true today just as it was true then. so there is a danger that begins when you are at parity and becomes very severe when you become in a minority or a inferior position.

History may be incorrect about the future, but it is well worth reading and thinking about.

Mr. DELLUMS. Let me just come at the question in one other way. It seems to me that the Soviet Union, while it may be one to 2 to 3 years behind us technologically, in a matter of a few years they may get there, it seems to me they have demonstrated the scientific wherewithal, the economic resources and the will to go wherever they think they have to go in response to our perceived superiority. So the question is: what do we really mean by superiority? Isn't that a fleeting thing? Does that not occur for 1 year or 2 years or 3 years and suddenly there again? Does that mean that this is a never ending process and in your opinion where is this leading us?

Mr. MORROW. Well, I think it is very clear where it has led the Soviets. It has led them to having to spend a very large fraction of their gross national product in the area of national security. There are arguments about what the percentage is. It used to be said it was 15 percent, then the estimates were raised to 20 percent. My own perception is that it is more than 30 percent. It has gotten to the point where it has, in the view of the younger people coming along in that country, severely damaged their prospects for the future, and they, I think, are saying to themselves and are saying to us, we cannot go on like this. We cannot keep up the pace. This, I believe, is one of the reasons for the extraordinary shrill response to the SDI initiative.

You can argue whether the SDI initiative was rational on our part or realizable but there is one thing you cannot argue about and that is the strength of the response. It was hysterical. The reason I think for that hysteria is that the Soviets had invested the blood of their people in building those strategic systems. Literally thousands of people gave their entire lives to that endeavor. To see the possibility of that all being swept aside or to see the possibility of having to invest that much again to keep up was something they did not want to contemplate and would like to avoid at any possible cost.

So, yes, it is true that they have kept up to us within 5 years or whatever you might say is the delay time on the average, but it has been at a terrible price and one that I think they are saying they don't think they can continue making. That price is too great.

We have been spending 6 percent of our GNP, or maybe it is 7 percent, I don't know, and all they can think about is what if those Americans should spend 15 percent of their GNP, we would be utterly crushed under those circumstances, we couldn't match it. They are very concerned. So I think that yes, they have kept up, but we have, particularly if we spend our money wisely and shrewdly, the ability to not only maintain the current load but to move even further ahead in the various areas. I am not advocating we build more strategic weapons, I am advocating we think very carefully about the future and see how we can invest our R&D money and our procurement money to gain the maximum advantage with that money, the most back for the buck as Dr. Herzfeld said.

Mr. DELLUMS. Just one last question. I can't resist one editorial comment. I think I totally agree with you the Soviet Union has paid an enormous price to pursue this course, but when I look at

the poverty, the hopelessness, the crime, the drugs and the major social problems that are beginning to magnify themselves in this country, if not geometrically certainly arithmetically, I think we have paid one hell of a price to move down this course as well and I think there are millions of American people who are paying an incredible price for us pursuing this course with the principles of benign neglect and certain priorities that have us addressing a perceived threat out there when internally our Nation is falling apart and you and I know that is happening on a daily basis, a generation of our children going down the tubes.

The U.S. defense planning efforts highlights the need to rely on our technological superiority, and I think you have alluded to that as well as a focus for future systems being superior. Let me come at it a little different way. Is this really an appropriate strategy? Can it lead to weapon systems sophistication that could in the end be too complicated to use or even too unreliable?

Mr. MORROW. It certainly can if you proceed to push the technology too strongly. On the other hand, complexity is not an argument for not taking on new technology. The complexity that we find inside the PC's that sit on all our desks—actually one doesn't sit on my desk but my secretary's desk—that is an enormous sophistication in that machine. We have learned how to package it and how to make it reliable. If you do that, then you can live with it, just like you live with your modern automobile, which is a very complex device compared with the one that maybe perhaps your grandfather drove or my grandfather drove.

You must be careful to make sure that you do the R&D necessary to make sure that you have reliable equipment and that people know how to run it and that it is simplified to the point where it will not cause problems. If you do that, then I think you can live with complicated technical equipment. If you do not, the concerns that you have are certainly true; you will live to regret having that complex equipment around.

Mr. DELLUMS. Thank you very much, Dr. Morrow. I appreciate your response.

Let me first give Professor Carnesale an opportunity to respond to any of the questions that I have already directed to Dr. Morrow if you wish to comment to any of those. I certainly want to give you that opportunity.

Mr. CARNESALE. Just one short one.

I think you said something very important about the SDI debate. President Reagan used to say if this is such a bad idea, how come the Soviets are so opposed to it? I think Dr. Morrow gave the reason, which is what I used to say, because it would cost them a lot of money. Now you don't even have to assume that it would be cost effective. Let me take hypothetical numbers that I don't argue for the veracity of the number, but if this system were terrible and it cost us $1 trillion to deploy it, (this was Jim Schlesinger's estimate for a nation wide defense) and suppose the Soviets could overcome it with only half a trillion dollars more of offense. Clearly this is not a cost effective system, but I think you would still get the negative Soviet response.

They didn't want to spend half a trillion dollars to be back where they started. So it really was not surprising that the Soviets vehe-

mently opposed getting out of the ABM Treaty and having to make enormous investments. Their opposition gives you no information as to whether it would have been to our advantage or not. I think it would not be to our advantage to terminate the ABM Treaty, but that is not a theological argument against defenses for all time. I think you have just given the answer to President Reagan's question which applies to a great deal of the competition, that you may wind up back where you started at great cost to both of you and the fact that we spent less doesn't necessarily make it in either our interest or the Soviets'.

If both sides could avoid the whole mess and use the money for something else, they might well both be better off.

That doesn't mean I imagine suddenly stopping spending on R&D. That is the last place I would stop spending because it is to our advantage. But is an argument for thinking more broadly not only of this unilateral advantage, if I can spend $10 and he has to spend $20, I have won, not if I am back where I started and it costs me $10. The money might better be spent even though it is to our advantage. That is an arms control argument rather than—and I think it is the best argument for arms control.

Mr. DELLUMS. OK. Professor Carnesale, how should or should the United States restructure its R&D program to react to recent Soviet arms reduction initiatives? Should it be restructured? Should we refocus or continue to march down the same way?

Mr. CARNESALE. Frankly, Mr. Chairman, I think recent Soviet initiatives may be an excuse rather than a reason for badly needed restructuring. The time scales don't fit. I mean, imagine if we were witting in this same room talking about what we should be doing for the next 15 years, which are weapons time cycles, no one would have mentioned Mr. Gorbachev's name. Or if 15 years before Hiroshima and Nagasaki people had been planning how to fight World War II, nobody would have heard of nuclear fission.

So I think time scales don't fit very well. I suspect that the R&D part of our defense effort should be less reactive to Mr. Gorbachev than other aspects of defense spending. Fortunately, Mr. Gorbachev may shake up the system enough so that we might pay more attention to things we don't normally pay enough attention to.

For example, take the problem of nuclear proliferation. It is happening slowly. Surely we should try to slow it. What else should we be doing? Virtually no one is working on U.S. military or intelligence or other kinds of responses to the fact of proliferation of weapons. Because we are mesmerized by the Soviet devil, it is a lot easier to get funds for things if the Soviets are the adversary. Good proof of that is watch the admirals when they come up to the Hill for aircraft carriers which, in a war against the Soviet Union, wouldn't be worth anything. There are good reasons to have new carriers but the Navy has to pretend they are for use against the Soviets, otherwise it will never get them. I think Gorbachev—also some other problems that are further out that we tend not to think of that are the avoiding of technological surprise. An easy list might be what about with the modification? You are not going to find practical people worrying about it. Is it something we ought to be worrying about?

We should also pay attention to areas such as artificial intelligence, superconductivity, genetic manipulation, and mind-affecting drugs. You can't show they are needed because of what we know the Soviets are doing. If you really are thinking about the longer term, breakthroughs in many of these areas are certainly imaginable in a time scale less than 50 years. It was just 50 years ago that fission was discovered. We know you don't have to go that far out. I would like to see more of our attention paid to other threats that we might face and not just the Soviet threat.

Mr. DELLUMS. I appreciate your response. Let's stay within Dr. Morrow's 10-year time span. There is now beginning to be a constituency that will advocate strategic force modernization, it is coming forward very strongly. Should that be delayed? Should that be slowed down? Is there any efficacy in going forward with strategic force modernization at this point given your way of looking at strategic weapons?

Mr. CARNESALE. The answer is in some cases yes and in some cases no. I will try to be somewhat more specific.

I have already indicated what I think are the reasons for modernizing the ICBM force and by that I mean narrowly trying to have survival ICBM's although I believe that problem is exaggerated in its importance, recognizing it only represents 20 percent of our strategic force. In any scenario other than an all-out exchange between the two nations—which I believe are among the least likely war scenarios—we will have lots of ICBMs. The only scenario you can imagine in which we don't have any ICBMs available is one in which the Soviet Union has attacked the U.S. with at least 2,000 nuclear weapons, not to mention going after our command and control facilities and subs in port. This is not a limited nuclear war by any stretch of the imagination. In this all-out war, we would have little need for the kinds of limited attacks that ICBMs are so very good at.

So I think the ICBM modernization time schedule should be geared with having in mind the real danger, which is the submarines might become more vulnerable and that is not an emergency.

On the SLBM side, I think there is a question of obsolescence. The fact is while everybody blames the retirements of the Poseidon submarines on the START Agreement, the fact is it has nothing to do with the START Agreement. The START Agreement would not cause any premature retirement of Poseidon boats. That is what the Navy has planned to retire them anyway.

So I would continue with the Trident submarine program and the D–5 missile program, primarily because we have so many eggs in the sea-based basket.

With regard to the Stealth bomber, I certainly would—well, I was going to say I certainly would slow it up, but since nobody knows what the schedule is, it is hard to know what that means. I think everybody is talking about slowing it up. I certainly would fly before I start spending $600 million a copy for planes. I think Standoff aircraft with cruise missiles plus the B–1, (if it can be fixed so it can penetrate,) should be sufficient. That is a much lower price, but I certainly would not spend the money to produce the Stealth bomber at this stage. You probably can't cancel it completely. I realize it is not economical to have a slow production rate

but that may be what is required politically to keep the program alive.

Mr. DELLUMS. One other question.

You again within this 10-year time span look forward. We have now entered into the INF Agreement but I now hear another scenario marching forward under, with the label modernization of tactical nuclear weapons. In that 10-year look down the road, do you perceive the need for research and development or aggressive or not so aggressive research and development programs designed to pursue new initiatives in tactical nuclear weapon modernization against the backdrop of the INF Treaty?

Mr. CARNESALE. I believe tactical nuclear weapons and INF weapons more so than any other nuclear weapons, are fundamentally political weapons. Remember that we never felt the need for modern INF until Chancellor Schmidt's speech in the late 1970's. We had intermediate range missiles in Europe in the 1950's and 1960's that we took out because we thought ICBM's and SLBM's were much better. We put INF weapons in Europe again as a technical solution to a political problem within the alliance. I believe that the handling of the force modernization process should be equally political in nature. Alliance cohesion is far more important than any military capability of theater nuclear forces, particularly tactical nuclear weapons.

If our allies were to come to believe that our commitment to them is measured by our willingness to modernize the nuclear weapons, then we should modernize the weapons. If they were to prefer that we didn't modernize and we shovel it down their throats, I think we would have undermined our own objectives. So I believe this is an important political calculation but the notion that the outcome of a war in Europe would depend on whether Lances had been upgraded or not in a military sense is absurd. But if we cause great schisms between ourselves and the Germans or the French or the British over this issue, that could have a lot to do with the outcome of war in Europe or elsewhere.

Mr. DELLUMS. Thank you very much. I would like to finally turn to Dr. Herzfeld, and I appreciate all three of your patience in this regard. I would like to provide you with the opportunity to make any comments that you may wish to make on a random basis based on the questions that have been placed to the two gentlemen previously.

Mr. HERZFELD. I would be delighted to make a couple of very, very short ones.

You mentioned the very important aspect of threat assessment and this was not prominently featured in my statement because of shortage of time. I am very concerned with it and have worked on it for many years.

I would like to draw one feature of this to your attention because of its special relation to this committee. Our ability to tell what the threat is depends to a surprisingly large extent on how much R&D we do on military problems.

I have made for the last 20 years a kind of hobby of studying things we observe on the other side that we don't understand, the so-called enigma problem.

I have run a few studies with the Defense Science Board and other auspices on this.

I am concerned that the number of enigmas is increasing because we have a comparatively less strong R&D advantage and that is very worrisome because that is how real surprises can happen.

I am writing something that will address this in a bit more detail and should you or the committee be interested, I would be happy to committee and talk about it some time.

I think it is a key issue for an R&D strategy, and I really appreciate you bringing this up.

I would like to address your comment of what is the danger of being even technologically. The danger of being even is that the Congress and the people probably won't support a large enough force to keep us safe if we are just even in quality.

I am worried about external threats to this country. Don't think I am making them up. Don't think they are just my nightmares. The less ahead we are, I think the more threat there will be from whatever quarter, not necessarily only one country or two, lots of places that don't like us for whatever reason.

Our safety depends not entirely but to a good extent on deterrence, meaning on other peoples' fear of taking us on, just sheer calculation that they are going to get into more trouble than they want to be in.

I believe that overall the cheapest and politically the most affordable way is with higher quality because then we can afford smaller quantities and we have to send fewer of our people out there into risky situations.

Mr. DELLUMS. Could I ask you a question at this point? This is a layperson's question.

If the thrust is toward higher quality as opposed to larger quantity, can you not envision from your vantage point a possibility of a development of an exotic level of technology that gets beyond our ability to control?

Mr. HERZFELD. Yes and no. That comes in two layers.

Let me take the easy part that Dr. Morrow addressed.

Mr. DELLUMS. I think each time we move forward, we create geometric problems for arms controllers and I envision that some day we may get beyond our capacity to control?

Mr. HERZFELD. I don't think so. I am an optimist as a human being in the sense that I don't think that our creations are going to run away from us except perhaps I am more concerned about the biological area than I am about the engineering or aircraft or computer area.

I don't think we are Frankensteins about to create a monster. I don't see mankind doing that. I think we could do things accidentally. I think we have to worry about the environment, that we don't accidentally ruin that because that may take a long time to fix and be expensive to fix.

I think awareness has been raised all over, including President Bush who is concerned about it. That is a comforting thought, but this kind of a grand Frankenstein problem, I don't think, is real with the conceivable exception of genetic engineering and some of the biological things that go along with that.

I am not an expert in that.

Mr. DELLUMS. I appreciate your response. I was trying to raise the question of whether or not in the context of national security that we, in pursuing higher quality weapons that we develop weapons that get beyond arms control calculations that the weapons become more sophisticated and complicate the problems of verification, et cetera.

I am suggesting in this quest for higher quality can we not pursue nuclear military technology that gets beyond our ability to sit across the table and figure out how to control?

Mr. HERZFELD. That is hard to predict.

I mentioned chemical warfare as an area where there is already a lot of concern and there should be more because it is so hard to inspect and verify because chemical plants are ubiquitous, easy to change from producing A to B.

There are many toxic substances produced in huge quantities for appropriate reasons, but they could be modified easily to make powerful poisons to people and livestock.

That is a real problem that exists and that is not being addressed adequately, I feel, by the public at large.

Experts are very worried about it, but it hasn't taken on appropriate significance in the public debates.

I am less worried about nuclear weapons. They are not going to get as small as a golf ball.

With the physics, I believe, it is conceivable that in 50 years some physics come along that makes that feasible. They are not going to be easily made without large installations.

I am less worried about that. I think there are lots of bread-and-butter kinds of problems to solve that are in the 10-to-20-year time scale, and I agree with some of the areas mentioned that we should pursue, some kinds of artificial intelligence would be very helpful, for example, in requiring less training to employ advanced weapons.

You mentioned earlier the threat that we might build things nobody would know how to use.

I think that we know how to do something about that. We can build essentially foolproof things, but the kinds of issues you raise are very important. I think we are going to be speculating about that for a while before we have any really sound answers we can get our teeth into. That is how I see it.

Mr. DELLUMS. Dr. Herzfeld, I appreciate that.

My colleagues know that I could keep you here all day because there are a number of questions the subcommittee has and you are bright and competent human beings and have a great deal to offer and I am more than willing to try to absorb them.

I don't want to impinge upon your time any further. I would like to thank each of you. You have been very kind and very generous.

As I said, this may be a naive effort, but it is an effort on our party to try to challenge my colleagues to think long term and to establish a broader policy framework within which to function and it is a difficult proportion to try to turn that corner.

I appreciate you coming before the committee to try to do that and I think you have made an enormous contribution.

If there are any thoughts or ideas that you would like to share with us, papers, that are triggered by the kinds of questions that

any and all of us have thrust at you today, we would deeply appreciate it.

We would like to try to make it part of the record and to the extent that we can read it and absorb it, we will.

[No information was received for the record:]

I thank all three of you for your time and effort in this regard.

The subcommittee will adjourn until Tuesday next when it will convene at 10 a.m., on the issue of the technology and industrial base of our society.

The subcommittee stands in adjournment.

[Whereupon, at 4:38 p.m., the subcommittee adjourned, to reconvene at 10 a.m., on Tuesday, February 28, 1989.]

# DEFENSE INDUSTRIAL AND TECHNOLOGY BASE

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Tuesday, February 28, 1989.*

The subcommittee met, pursuant to call, at 10 a.m., in room 2118, Rayburn House Office Building, Hon. George (Buddy) Darden presiding.

## STATEMENT OF HON. GEORGE (BUDDY) DARDEN, A REPRESENTATIVE FROM GEORGIA

Mr. DARDEN. Good morning. The subcommittee will come to order. I will be substituting, of course, for Chairman Dellums.

[The following statement of Hon. Ronald V. Dellums was read by Hon. George (Buddy) Darden.]

"Today we are continuing our hearings on research and development issues related to our future needs. We hope to establish today a framework by which we can appropriately assess not only the efficacy and consistency of Pentagon RDT&E programs, but also to determine the condition of the technology base to support these plans.

The defense industrial and technology base provides the means by which our R&D plans become a developed technology and eventually become the reality of an operational system. We have had the opportunity to review recent assessments on this subject that indicate that we are in serious trouble on a number of fronts.

Today the subcommittee will turn its attention to our industrial and technology base to look more intently at the problems and begin to focus our attention on the effectiveness of our RDT&E resources to instill a spirit of cooperation with industry and Government and to better prepare for opportunities to maintain not only a strong industrial technology base, but a work force of qualified people in the pipeline to maintain it.

To this end, the chairman has invited three experts to testify on the issues of U.S. technology strengths, the industrial tech base, and the relationships for system developments that are consistent with national strategy objectives.

I would like to welcome, on behalf of Chairman Dellums and the entire committee, Dr. Ashton Carter, Acting Director of the Center for Science and International Affairs at Harvard University; Dr. Donald Langenberg, Chancellor of the University of Illinois, Chicago, and President-elect of the American Association for the Advancement of Science; and Dr. James Colvard, Assistant Director of the Applied Physics Laboratory at Johns Hopkins University.

However, before we begin, I would like to yield to the subcommittee's ranking minority member, the Honorable Bill Dickinson, for such statement as he might make for such time as he may consume."

**STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE**

Mr. DICKINSON. Thank you, Mr. Chairman, and I would like to join with you in welcoming our witnesses here today. I would like to thank each of you for taking your time to come to testify, to share with us your perception of what can be done to alleviate some of the problems that are obviously in existence.

Our last hearing addressed the subject of long-term research and development from a policy perspective. It is my understanding that today we will address it from an industrial technology base perspective.

There are two broad issues relative to the technology base that have concerned me and, I am sure, many members of the committee in the past. The first is the impression that there exists an adversarial relationship between Government and industry. Obviously, there cannot be a meaningful mechanism for efficient and useful development of technology if the relationship is truly adversarial.

We would appreciate your views on, first, is this, in fact, the case, and if so, what would you suggest to ameliorate the situation or correct it?

The second is the development of a superior technology outside the United States. I view this as not any major threat to us, but rather as a fact that we have to both recognize and deal with. I think we have gotten complacent because we have always been the technological leader in the world, but with the advent of more and better electronic equipment and so forth, we see that other nations, not just Japan, have developed a very impressive technological base, and we see that they do better than we do in certain areas.

How we manage the situation and how we use our defense resources with respect to this relative to our national defense are important. For instance, we are considering now, according to the media the joint development of a new fighter plane with Japan. We will have a co-production of, let's say, an upgrade of the F–16 and let the Japanese co-produce or be a partner with us and what do they give and what do we get or do we start with something new, rather than suggesting that the Japanese start from square one and develop their own.

If we do this, what do we provide and what do we get? Are we giving away our technology? Are we making this available to potential competitors that will come back to haunt us or do we enhance our capabilities by learning from our prospective partners?

These things are of real concern to us in the short and long term and I think you gentlemen have a reservoir of expertise and knowledge on this that can be helpful to us. We do appreciate your coming here today and thank you very much.

I yield back, Mr. Chairman.

Mr. DARDEN. Thank you, Mr. Dickinson.

As I said before, we are delighted to have such a distinguished panel here and if there is not objection from the membership, we would like to proceed in this order. We will have the statements of the various witnesses in their entirety before any questions so that we can consider the totality of the testimony before any questions.

We would ask that the witnesses testify in the following order: First, Dr. Carter; then Dr. Langenberg and then Dr. Colvard. We would first call on you, Dr. Ashton B. Carter, for your statement. It is a pleasure to have you this morning and we appreciate you being here.

## STATEMENT OF ASHTON B. CARTER, ACTING DIRECTOR OF CENTER FOR SCIENCE AND INTERNATIONAL AFFAIRS

Mr. CARTER. Thank you for inviting me to appear here today before this subcommittee to speak about the defense technology base.

My background is physics, but I have worked on technical matters related to national defense in academia, in the Office of the Secretary of Defense, and in the Congressional Office of Technology Assessment.

I am currently Acting Director of the Center for Science and International Affairs at Harvard, a member of the Kennedy School's Science, Technology and Public Policy Program and a consultant to a number of Government defense agencies.

Three major issues relating to defense R&D are receiving increasing attention in our country today. First, the health of the defense technology base. (In speaking of the defense technology base, let me say at the outset that here and throughout my remarks, I mean the entire system of technological innovation for national defense and not the narrower budgetary definition of the tech base as comprising 6.1, 6.2 and sometimes 6.3(a) budget categories.)

Second, the strength of the link between the defense technology base and the downstream development and efficient acquisition of high-technology defense systems; and third, the relationship between the defense technology base and the commercial technology base, which is so important to international economic competitiveness.

I understand that the other two panelists will address the first two issues. My remarks will focus on the third issue, which I will refer to as the dual-use relationship. It concerns technologies that are dual-use; that is, technologies with application to both defense systems and to commercial products.

The key aim of policy in this area is to make the defense and commercial technology bases mutually reinforcing or, to use the common phrases, to increase spin-off from defense technology to commercial applications and spin-on from the increasingly international commercial technology base to national defense.

My colleagues and I in the Science, Technology and Public Policy Program at Harvard have been trying to establish an understanding of the dual-use technology relationship with the aim of providing an analytic foundation for the nation's search for ways to in-

crease the synergism of its defense and commercial technology efforts.

The motivation for understanding the dual-use technology relationship is apparent from reviewing U.S. patterns of investment in military and commercial technology. The R&D intensiveness of the U.S. economy, at least as measured by our annual investments in R&D, both private and public, divided by the Gross National Product is comparable to that of our major commercial competitors. But if one subtracts out defense R&D spending and looks at nondefense R&D divided by GNP, the United States fell behind Germany and Japan by this measure two decades ago.

Taking these numbers at face value, and budget numbers, of course, are not completely accurate measures of technical substance, one concludes that we had better be reaping some economic benefit from our defense technology base. This is all the more true since defense R&D has grown much faster over the decade of the 1980s than nondefense R&D.

In fact, taking account only of the defense R&D budget probably understates the portion of the national R&D effort that is military related. If one combines direct DOD and DOE defense contract R&D, reimbursed and nonreimbursed independent R&D and bid and proposal expenditures in private industry, and if one takes estimates made by economists of the amount of private R&D investment aimed at winning military business, the total defense-related investment probably adds up to 40 percent or more—almost half—of the total annual national investment in science and technology.

Next, the trends in these budget numbers have caused many to ask whether the DOD is fulfilling its national responsibility in all categories of R&D. Most——

Mr. DICKINSON. Dr. Carter, let me apologetically interrupt you. I don't have a prepared statement from you and I didn't understand the last thing that you said about half of the total investment. Would you just repeat that part, please.

Mr. CARTER. Right. I was trying to get a handle on the overall fraction of the national effort in science and technology that is defense-related. Part of that contribution comes directly in defense R&D contracts. Other parts come from the independent R&D program which reimburses private companies for a fraction of expenditures they made on their own behalf in the hopes of winning defense business. DOE does some defense-related work and then there are other bits and pieces.

If one adds all of that up, it adds up to about half of the total national investment annually in R&D.

Mr. DICKINSON. The DOD expenditure, you are saying, amounts to about half?

Mr. CARTER. The DOD part plus other defense-related parts.

Mr. DICKINSON. OK, thank you.

Mr. CARTER. Most defense R&D is, and has always been D and not R, of course. One expects defense R to be more efficient at producing dual-use innovation than defense D in a dollar-for-dollar comparison, though in aggregate, defense development might be more important than research because it is so much larger.

The orientation of defense R&D toward the downstream engineering of specific weapon systems, that is, toward D, has accentu-

ated in the 1980s. Total defense R&D has roughly doubled in real terms over the decade, as has the defense procurement served by defense R&D.

Operational systems development has grown even faster than overall defense R&D or procurement, reflecting the large backlog of new weapons awaiting funding for completion. But the 6.1 and 6.2 accounts, respectively, research and exploratory development, the early end of the pipeline, hardly grew at all during the 1980s.

In 1987, DOD spent less than two-thirds as much on basic research as it spent in 1965, in inflation-adjusted dollars.

The 6.3(a) budget category, called advanced technology development, is sometimes combined with 6.1 and 6.2 to comprise the defense technology base. If one combines 6.1, 6.2 and 6.3(a) in this way, one finds that because of the explosive growth of funding in the 6.3(a) category in the 1980s, the fraction of total defense RDT&E devoted to the tech base has not changed much during the decade. However, most of the growth in the 6.3(a) account is due to the creation of the Strategic Defense Initiative. Until recently, all SDI spending has been categorized as 6.3(a) by administrative decree, though the program actually supports a wide variety of kinds of technology work.

In general, even outside of SDI, the theoretical line separating 6.2, 6.3(a), 6.3(b), 6.4 and operational systems development are not so sharp in practice, and there is considerable latitude to shift funding for a given technical activity around from budget category to budget category. But my main point is that 6.1 and 6.2 have not enjoyed the same growth as the defense budget and the overall defense RDT&E budget in the 1980s.

Beyond these raw budget numbers, another motivation to understand the relationship between the defense technology base and the commercial technology base is provided by the intensity of policy attention today to spin off and spin on and the spate of policy proposals being advanced to increase the synergism and decrease the barriers between the defense technology base and the commercial technology base.

Recent reports of the Defense Science Board on Semiconductor Dependency Superconductivity, the Defense Industrial and Technology Base and other reports underscore this heightened attention.

To decide among competing policy proposals requires a disciplined and fair analytic understanding of the relationship between the defense technology sector and the commercial technology sector. But one is struck by how widely views differ on this subject.

Some claim that the net effect of the large fraction of U.S. R&D devoted to national defense is negative and hurts our world economic position. Others claim that defense R&D is an important source of our technological strength.

Now, it is not surprising that the link between defense R&D and commercially profitable products should be somewhat hard to measure. After all, within the defense community, it is widely believed that defense R&D is not closely coupled enough to weapons production, let alone to commercial production, and likewise, in the commercial world, it is frequently said that the linkage between technological innovation and the downstream process of commer-

cializing technology is elusive. Linkages from sector to sector must be even harder to get a handle on.

But there is a more straightforward reason for the divergence of views about the effects of defense R&D on the commercial economy than the difficulty of pinning down the mysterious process by which technological progress is made.

To an extraordinary degree, different analysts have different standards of comparison in mind when they assess spin-off from defense R&D. Since they are using different standards, it is little wonder that they arrive at different judgments. For example, the standard most often used by critics of defense R&D, including most studies by economists, compares defense R&D to privately funded R&D performed by commercial companies. That is the comparison.

The first step in these analyses is to try to estimate the rates of economic return on investment in R&D, comparing DOD-funded R&D to privately funded R&D.

These analysts do this for an industry, an industrial sector or for the economy as a whole, and they usually find that commercial R&D gives higher returns on investment than defense R&D. Now, it is, of course, not surprising that dollar for dollar, the most efficient way to pursue technology of commercial promise is not to do defense R&D and then hope for spin-off. We should value our defense R&D investment first and foremost for its contribution to our national security, not for its commercial promise.

The second step these analysts take is to try to prove that defense R&D displaces or crowds out private R&D, so that a dollar spent on defense R&D takes away a dollar of private R&D or some fraction of a dollar larger than the ratio of the rates of return.

For reasons I don't have time to go into here, both of the steps in these analyses are questionable, meaning that the specific results are questionable, but my main point is that these analysts are implicitly comparing defense R&D against a comparable dollar volume of commercial R&D. This comparison would only be relevant for policymaking purposes if one knew a policy that would have the effect of transferring a dollar of defense R&D spending to a dollar of R&D spending in private industry. Simply cutting defense R&D spending, as these analyses seem to suggest, will not necessarily have this effect.

A second standard, very different, is applied by proponents of spin-off from defense R&D. They display all the commercially useful technologies that they imply would never exist if not for their program. NASA, and more recently, SDI, have issued reports of this kind.

They compare the spin-off from their particular R&D project to doing no R&D at all. Since the only implied alternative to the project in question is no R&D at all, the results of this comparison are easy to predict without doing any analysis. They are also useless for policymaking purposes, since the alternative to these projects, at least in the short term, is usually not unemployment for the scientists and engineers working on them, but to have these scientists and engineers work on some other project.

For example, most of the dollars and people now going to the SDI would probably be going to other projects in the defense R&D complex if they were not going to SDI, projects associated with air

defense, missile warnings, space track, intelligence, spacelift, ASAT and so forth. In fact, these programs were the ones that were aggregated to make SDI.

Here the displacement effect is obvious, and raises the question of whether we get more spin-off with SDI than we would get if the same people were working on other projects.

A third common practice is to imagine that if the marginal budget dollar were not going to defense R&D, it would go for procurement or some other non-R&D purpose in the budget. This standard of comparison is common among champions of spin-off within the defense community. It is the bigger-pie argument: spending more on defense R&D does not displace other R&D by buying up skilled scientists and engineers or bidding up the cost of R&D in the private sector, according to this view. Spending more on defense R&D makes for a larger overall pie of R&D in the United States and it is wrong, according to this comparison, to imagine that the country would spend as much as it does on science and technology if not for the national security imperative.

Fourth, some analyses compare defense R&D to R&D funding by other Federal agencies. The question here is whether defense R&D is stimulative of spin-off relative to R&D in NASA, DOE, NSF, the National Institute for Standards and Technology and so on. This comparison is different from the previous three. It is important when it comes to choosing to situate new technology initiatives for semiconductors, materials, superconductors and so on within one or another Federal agency.

Finally, some advocate federally funded civilian technology initiatives designed to replace defense R&D as a Federal stimulant of civil innovation. The Government has tried from time to time to sponsor technology programs of commercial importance directly, from the Civilian Industrial Technology Program of the Kennedy administration to the Cooperative Automobile Research Program of the Carter administration, and these programs have generally been viewed as failures. It is difficult to sort out the causes: poor technical opportunity, poor management or a hostile political environment.

One could go on like this at some length. I know of no less than five more kinds of analysis that people have done of the spin-off question. My point is that defense R&D is being held to very different standards in these various comparisons. But the comparison chosen ought to be related to the policy alternative under consideration and not to some other standard.

For this reason, I cannot offer a single overall assessment of how effective we are at reaping economic benefits from our defense R&D spending and I don't believe that such general assessments have much meaning.

The relationships between military and commercial technology and the mechanisms of spin-off have been quite varied in the past. My second main point is we can expect them to be similarly varied in the future. Too often, we look back on the famous cases of spin-off in the past, microelectronics, computers, aircraft engines, machine tools and so forth, and try to draw general lessons about how to stimulate dual use, as though one or the other of these examples was a model of successful dual use.

By thinking in terms of one experience, either fruitful or disastrous, one will tend also to conceive of one ideal relationship between military and commercial technology to which we ought to aspire, but in fact, there is and has been a great variety of relationships between the defense technology base and the commercial technology base.

For example, the celebrated case of the birth of semiconductor technology in the 1950s and 1960s, from the transistor to the integrated circuit, was not, strictly speaking, a case of successful defense R&D. It was a case of what is called procurement pull.

The key points of technological progress in the development of semiconductors did not take place under the sponsorship of defense R&D contracts; it was defense procurement, not defense R&D that made the difference. DOD, and also NASA, made it known that they would pay virtually any price for compact, lightweight and powerful computers. With that inducement, industry was willing to invest its own resources in R&D and the Government paid the initial costs of getting the industry down the learning curve.

So here was useful spin-off, but it didn't come by the mechanism that one normally thinks of.

Another type of indirect support of commercial technology arose in the case of satellite communications. Here the Government's own large space program, especially the development of space launch vehicles, made it economically possible for a related commercial technology to grow up at the margin of a larger Government effort. Again, it was not defense R&D, per se, that led to the spin-off.

These days, other types of dual-use relationships are growing. One is the DOD's effort to avail itself of commercial technology with off-the-shelf buying, the most direct form of spin-on.

Another is Sematech, which represents a deliberate attempt at industrial technology policy, accomplished in part through defense spending. All of these types of relationships are quite different, and again, the trick is not to find a single ideal, but to figure out which type is best suited for what you are trying to accomplish.

The answer will be different for semiconductors than for superconductors, for process than for production technology and so forth.

Despite all my warnings about drawing general judgments about the relationship between the defense technology base and the commercial technology base, let me close with the following conclusions.

First, it is probably the case that the most important influences of defense R&D on the commercial world are quite indirect, take place over long time scales and involve product technology more often than production technology. These traits may explain why it is so hard to trace and measure spin-off, even though the spin-off is there.

Second, the DOD affects the commercial technology base not just through its R&D contracts, but also through its procurement practices. In fact, procurement might be the more important influence, particularly among second-tier defense suppliers and particularly with regard to production technology.

Third, synergy between defense and commercial technology is greatest when three criteria are met. First, when the defense and

commercial worlds have fairly similar goals as far as the substance of the technology is concerned. For example, military and commercial jet engines have shared a fruitful process of co-development because the technical hurdles each sector was trying to surmount turned out to be similar. Spin-off from, say—just to take a clear example—a nuclear bomb-pumped X-ray laser to the commercial world, while not necessarily absent, must, of course, be more indirect than in the jet engine case. One of the questions for dual-use ventures like Sematech is whether the technical needs of the defense and commercial worlds coincide enough to make collaboration fruitful.

The second requirement for technology transfer between defense and nondefense is that there be people an institutions that do both types of work, since most observers agree that people are the most efficient agents of technology transfer. Unfortunately, those relatively few companies that do both defense and nondefense work tend to segregate the two types of work in separate organizations. The CEOs and technology managers of these companies generally say that even when the technologies being pursued in the two organizations are similar, it is difficult to merge the two because the engineering, marketing and bookkeeping practices of Government and the private sector are too different.

This brings me to the third requirement for successful dual use. The nontechnical barriers to dual use, such as different technical standards in defense and nondefense, security restrictions, barriers to proprietary control of technology and so forth, need to be lowered to the greatest extent possible.

Finally, there may be instances where dual use is not practical, either because the technical goals of defense and nondefense are not similar enough, or when it is not practical to surmount the nontechnical barriers. In these cases, segregation might be the wisest course for both sectors.

Thank you, and I will close there.

Mr. DARDEN. Thank you very much, Dr. Carter.

Our next witness is Dr. Donald Langenberg, who is the Chancellor of the University of Illinois. It is a pleasure to have you here this morning. Please proceed with your testimony.

## STATEMENT OF DONALD N. LANGENBERG, PRESIDENT-ELECT, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Mr. LANGENBERG. Thank you, Mr. Chairman.

Mr. Chairman, members of the subcommittee, I am Don Langenberg, Chancellor of the University of Illinois at Chicago, but today I am appearing as President-elect of the American Association for the Advancement of Science.

The AAAS has about 133,000 members, most of them scientists and engineers, and about 295 affiliated scientific, engineering and professional societies representing over 5 million people. AAAS publishes the Journal of Science and a number of science and technology policy documents. An example, called "R&D in the 1980s: A Special Report," I believe the members of the committee have seen.

I would like to summarize my written statement by making a few historical remarks about the role of military R&D in science

and technology development in the United States, look at some very broad overall numbers and trends over the past few decades of national R&D funding from all sources, including defense R&D, then point out several issues and make some observations on what those trends appear to show.

Military R&D has been a major factor in the science and technology development of this country for a very long time. I would remind you that the famous Lewis and Clark expedition, about which we all learned in school, was a militarily sponsored expedition.

Most of our major wars have also served as landmarks in the development of science and technology. The Civil War has been said to be the first major war fought with a significant element of new technology. It also gave rise to the National Academy of Sciences, chartered to advise the Federal Government on matters of science and engineering.

World War I gave rise to the National Research Council. That brought into play literally tens of thousands of scientists and engineers in aid of that war effort.

World War II, as we all know, was to a considerable extent won on the basis of major new technological innovations on our side. World War II also marked the beginning of a major increase in Federal support for research and development. I would like now to turn to a few of the trends that have occurred since the end of the war.

I believe you have some graphs and charts, and if you have them ready at hand, I would like to draw your attention to them. If you will look first at Figure 1B—I think it is erroneously called Figure 1A in the text—which shows a plot of total national R&D in constant dollars, 1982 dollars in this case, from 1953 to 1989.

Mr. DARDEN. Excuse me, is this the one entitled "Federal and non-Federal R&D Outlays"?

Mr. LANGENBERG. No, this is the chart labeled, "Total National Constant Dollars." It is Figure 1B at the top. I think it comes two or three sheets into the pile that you have.

You will note that over the period from 1953 to the present, total national support of R&D in real terms has grown substantially. It has grown about five-fold during that period, but the growth has not been steady. I would draw your attention to a long flat period between the mid-1960s and the late 1970s. Indeed, over the period 1968 to 1977, there was actually a decline of about 3 percent in total national R&D funding.

If you will now turn back to Figure 1A——

Mr. DARDEN. Before we leave this, this says "thousands" at the top?

Mr. LANGENBERG. Mine says "millions" at the top.

Mr. DARDEN. It should be billions.

Mr. LANGENBERG. It should, in fact, be millions.

Mr. DARDEN. Millions or billions?

Mr. LANGENBERG. Billions. You are right, billions. We should now be at about 100.

Mr. DARDEN. So this is—for clarification one more time, this is billions—at the top.

Mr. LANGENBERG. That is right. We are now at a level of just above 100 billion nationally.

If you will turn back to Figure 1A, which looks at the split between Federal and non-Federal, you will note that over the 1960s, the Federal share of that total national R&D funding reached almost two-thirds. It rose to almost two-thirds, and then subsequently declined, and over the past decade or so, seems to have become fairly stable at just a bit under half of the total national funding for R&D. The non-Federal sources account for a bit more than half.

Mr. DARDEN. Excuse me, is this just DOD R&D or total R&D?

Mr. LANGENBERG. No, this is total R&D from all sources, including private sources, industry, everything that can be separately accounted for as an R&D outlay or expenditure.

Over that period, from 1953 to the present, private sector support for R&D doubled over the decade between 1953 and 1963 and then slowed down. It picked up steam again in the late 1970s and since the mid-1980s seems to have slowed down a bit again.

In support of basic research, the basic part of the R has increased over that period. It has increased significantly during the first half of the 1980s. That followed a period of about 15 years of very little real growth on the basic research side of the R&D total. That growth, again, seems to have slowed down a bit in the late 1980s.

It is always interesting to take a look at the international competition, which has been referred to previously. If one looks at the proportion of the Gross National Product that is spent by this country and by other developed countries, you find interesting and very different behaviors. You will find some data on these in Figure 2 and in Figure 3. What you find in those figures is that for the United States, that proportion was high in the 1960s; it declined in the 1970s and it rose again in the 1980s.

Behavior for France and the United Kingdom tends to fluctuate a lot, but the two nations that are generally viewed perhaps as our major economic competitors are West Germany and Japan, and you will find that in those countries, there has been a steady and sustained growth in the proportion of Gross National Product, right from the early 1960s to the present. The total percentage of Gross National Product devoted to R&D by West Germany, Japan and the United States are now quite comparable.

There is a major difference, however, if you look at that part of the total GNP fraction that is devoted to civilian R&D, as compared with military R&D. The United States spends a considerable fraction of its R&D expenditures on military R&D and West Germany and Japan spend very little. So their Gross National Product fraction invested in R&D is devoted very nearly entirely to civilian research.

Now let me turn to looking just at the defense R&D trends. Since the early 1980s, Federal spending for defense R&D has grown much faster than any other category of Federal R&D. The previous peak was in 1965, but in the latter years of the 1980s, we have now surpassed that previous peak in real terms.

That growth, however, has been overwhelmingly concentrated in development, test and evaluation, the DT&E and RDT&E. If one

looks at the technology base programs—and for the moment, let me exclude SDI—they have been very flat over time. They have not participated in the large increases of other DOD R&D programs during the 1980s. You can see a plot of that if you will turn to Figure 9 toward the end of that package of figures and charts.

It shows a comparison of total RDT&E and the technology base, this case, defined as categories 6.1 and 6.2. That chart separates out SDI because there appear to be some questions about exactly how to identify SDI funding.

If you include all of SDI funding in the total technology base, then it would show about the same factor of 2 increase over the 1980s as total RDT&E. If you do not, the technology base is almost flat.

If you look within the technology base at the basic research 6.1 part and let me refer you here to our Figure 11, which shows DOD's 6.1 funding in current dollars and also in constant 1980 dollars, you will note that in constant dollars, 6.1 funding was high in the mid-1960s. It declined very substantially through the 1970s and has had a modest increase in the 1980s.

The current support in real terms for 6.1 funding is still about 25 percent less than it was in the mid-1960s in real terms.

The next graph, Figure 12, shows the 6.2 funds. You will find there that 6.2 funding in constant 1988 dollars was again high in the mid-1960s, declined through the 1970s and has experienced essentially no increase in the 1980s. Overall, the technology base defined as 6.1 and 6.2 has been very flat.

It constituted about a quarter—about 25 percent of total RDT&E funding in the late 1960s. Now it is less than 10 percent.

So one can see over this period of now close to three and a half decades some significant changes, some significant trends in total Federal R&D funding, in the balance between the R and the D, and in the balance between types of R&D, to the extent they can be judged by the sources of that funding.

Now let me raise some questions and make some observations. First, that long period of no real growth in total U.S. R&D investment through the mid- to late 1960s and through much of the 1970s undoubtedly had some downstream consequences. In my view, those consequences might well include the lowered U.S. economic competitiveness that we seem now to be experiencing and its consequences for our trade deficit.

That, together with the much higher proportion of R&D funding invested in civilian research in Japan and West Germany may well account, at least in part, for our lower manufacturing productivity overall than apparently is achieved in those two countries.

That investment strategy over that period, from the mid- to late 1960s, to the late 1970s, contrasts rather sharply and negatively with the strategies that appear to have been pursued by our principal economic competitors.

We can't go back and change what happened 20 years ago, but we surely ought not to repeat our mistakes. There has been an unfortunate tendency, both in the private sector and in the public sector, to view research and development, and particularly research, as a target for short-term adjustments to meet short-term budgetary problems. We have tended not, I believe, to take the long

view of the value of investments in R&D, whether it be public or private, whether it be defense or nondefense, and I suspect that if one looks at our current circumstances and looks back a sufficient distance, one can see some consequences of that short-sighted view.

As Dr. Carter has pointed out, there are many questions remaining after many years of analysis and research about the way in which flows and transfers of technology between the defense and the civilian sectors and between basic and applied research and development occur but there seems to be some evidence, in my view, that spin-offs from defense technology are perhaps a little more difficult to identify than they once were back in the 1960s.

It may also be the case that spin-ons have also become more important. Parenthetically, I have heard it remarked that nowadays, for a variety of reasons, including the long cycle times for the development of military programs you sometimes find much more sophisticated electronics in children's games and in fax machines than you do in modern military equipment.

There is some anecdotal evidence as well, I think, that the shadow of the Mansfield Amendment has been a very long shadow. Though that amendment was in effect only in the late 1960s, there still seems to be some tendency within the defense R&D establishment to follow the spirit of the Mansfield Amendment.

Whatever the overall impact the defense R&D may be on the national economy, I think we do need to be——

Mr. DICKINSON. Doctor, will you explain what the Mansfield Amendment is? I wasn't here then.

Mr. LANGENBERG. If I remember correctly, the Mansfield Amendment, by Senator Mansfield was in effect for one or 2 years in the late 1960s. It was an amendment to the Defense Authorization or Appropriation Act at the time which required that research funded by the defense R&D funding agencies had to have a demonstrable connection with the defense mission and with defense programs. The objective of that amendment was to suppress the funding of research just for its own sake or research in areas that did not have some clear and visible probable connection with planned defense needs.

Mr. DICKINSON. It was pure research, not research aimed at a particular goal?

Mr. LANGENBERG. That is one way to describe it, yes.

Mr. DICKINSON. Is that the wrong way?

Mr. LANGENBERG. No. I don't think there is a right way, to tell you the truth.

Mr. DICKINSON. Is there a better way?

Mr. LANGENBERG. Some of the research that is funded by defense now clearly would have been acceptable within the terms of the Mansfield Amendment. It has clear and obvious potential applications to visible established defense needs. Nevertheless, it can be quite pure in the way that that term is commonly used in the research community. There it is not an invariable distinction between pure and applied research; it is a matter of whether or not you believe or can perceive that the research is likely to have some direct beneficial effect on defense technology.

Mr. DARDEN. If the gentleman would yield, it is not in effect any more, though.

Mr. LANGENBERG. No, it is not now in effect.

Mr. DARDEN. What you are saying—to be sure I understand you correctly—is that it is a residual from the amendment and the philosophy that set it in motion continues to exist and continues to linger, with not any legal efficacy at all.

Mr. LANGENBERG. That is correct, sir.

Whatever may be the actual impact of defense R&D on the national economy, I think there is reason to be concerned about a relatively long and negative or downward trend in the relative emphasis in DOD's technology base relative to total RDT&E. It is in those areas, the technology base, where the commonality or the potential for dual-use technologies is the highest and where there is the strongest likelihood of payoffs in the civilian sector. These areas, as I have tried to show relative to total RDT&E funding in defense, have experienced a long and steady decline in their relative importance.

The Defense Department draws upon the total national technology base and, as Dr. Carter has pointed out, this extends well beyond that part of the base that is funded directly by DOD. The research programs in the Department of Energy, for example, and those in the physical sciences in the National Science Foundation, are just as much part of the national defense technology base, I believe, as those programs funded by defense, and so it is really appropriate to think in terms of that entire technology base. It seems to me one can ask whether DOD, which has historically played such an important role in establishing the national technology base for both defense and civilian purposes, really is today pulling its share of the load.

If one looks over the period, fiscal year 1980 to fiscal year 1988, at the real current dollar changes in the Federal funding agency budgets, which fund most research in the areas directly relevant to defense—and let me—which fund most of the basic research, much of it in areas relevant to defense—let me just look at three agencies: the Department of Defense, the National Institutes of Health and the National Science Foundation.

Defense had a total real growth in total R&D of 84 percent, but a growth in 6.1 research, basic research, of only 11 percent. NIH increased 34 percent in total R&D, but increased 59 percent in basic research and NSF had a 17 percent increase in both areas. On the whole, it has been a good decade for R&D and it has been a good decade for basic research, but the balance, the share of the market, if you like, or the contribution to the whole of DOD relative to those of other Federal sources has shifted significantly.

Finally, I would like to express the hope that the budgetary difficulties that this Nation is experiencing, the major Federal deficit that you all are trying to wrestle with, will not lead to cuts in the defense technology base programs which are proportional or perhaps larger than whatever cuts may be contemplated in the defense budget. These programs did not share in the major increases of the decade of the 1980s. They are the basis for the long-term technology base, both defense and civilian, of this country, and I believe they need continued strong support.

Thank you, Mr. Chairman.

PREPARED STATEMENT OF DONALD N. LANGENBERG

INTRODUCTION

Mr. Chairman and Members of the Subcommittee:

Thank you for your invitation to testify.

I am Donald Langenberg, Chancellor, the University of Illinois at Chicago. However, today I am appearing as President-Elect of the American Association for the Advancement of Science.

The AAAS is an organization of 133,000 scientists and engineers as well as having 295 affiliates representing over five million members in various scientific, engineering and professional societies. We publish the journal Science and a variety of science and technology policy documents. An example is R&D in the 1980s: A Special Report, sent to you previously.

In response to your invitation letter, I plan to discuss briefly the following topics: (1) the historical setting of defense R&D; (2) some overall numbers and trends in national R&D funding -- including defense R&D; (3) several trends in federal support of R&D; and (4) several issues and observations on defense R&D trends.

SUMMARY OF MAJOR POINTS

To provide a quick overview, I will list the major points which are presented in my full statement.

U.S. National R&D Profile

(1) Total national support of R&D -- public and private -- has grown substantially, although not steadily, over the past four decades. It has increased about five-fold in real terms (constant dollars) during this period.

(2) The federal share of total national R&D has stabilized at a little less than 50 percent -- after reaching nearly two-

thirds in the mid-1960s. It grew very rapidly from 1953 to 1965 -- four-fold -- but since then, during the past 25 years has increased slowly only by 25 percent.

(3) U.S. private sector support for R&D doubled (in real terms) between 1953 and 1963, grew at a slower rate until the first half of the 1970s, and then picked up steam during the late 1970s until the mid-1980s. More recently, another slowdown seems to be underway.

(4) Support of U.S. basic research was increased significantly during the first half of the 1980s both in the public and private sectors -- and in current as well as constant dollars. This growth followed a period of nearly fifteen years of very little real growth. However, in the latter part of the 1980s, this growth has slowed down.

International Comparisons

(1) Important economic competitors -- and political allies such as Japan and West Germany -- increased their national investments in R&D from 1968 to 1977 while the U.S. was experiencing a real decline (constant dollars).

(2) These same competitors, now and earlier, allocate far more of their R&D investment to civilian areas as compared with defen than does the U.S.

U.S. Defense Role in R&D

(1) The deep and pervasive influence of the military is an essential part of the history of U.S. science and technology. For example, the Lewis and Clark expedition (1804-1806) was a military research effort.

(2) More recently, World War II especially marked a watershed in terms of large-scale involvement of defense and R&D. Science and technology helped to win the war, and the Defense Department was a major force in helping to shape the direction, content and organization of U.S. R&D in the post-World War II years.

(3) In recent years, the Defense Advanced Research Projects Agency (DARPA) has provided major intellectual stimulus and financial support to various scientific and technological areas.

(4) Defense R&D has waxed and waned over time but now accounts for about two-thirds of total federal R&D -- and about one-third of the national total.

Defense R&D Trends

(1) Since 1981, federal spending for defense-related R&D has grown much faster than any other category of federal R&D. This growth has been overwhelmingly concentrated in development, test and evaluation (DT&E) activities associated with new weapon systems.

(2) Defense technology base programs -- excluding SDI -- have declined substantially in real terms over time. They have not participated in the large increases of other DOD R&D programs during the 1980s.

(3) The basic research part of defense technology programs has grown substantially in current dollars but only modestly in constant dollars since the early 1980s. Current support is still about 25 percent less than the level of the 1960s (in constant dollars).

(4) There seems to be some evidence that the 1970 "Mansfield amendment" continues to have a restrictive influence on DOD's support of basic research.

A FEW HISTORICAL NOTES

In his classic study, Science in the Federal Government: A History of Policies and Activities to 1940, historian A. Hunter Dupree shows in rich detail a century and a half of the federal government's role in science and technology. There has been since 1789 to the present day a keen appreciation by influential policy makers of the potential contributions of science and technology.

This is not to say that support and understanding of science and technology have been strong and consistent throughout our history. On the contrary, over time support has fluctuated widely, even for military purposes.

As my friend Harvey Brooks has observed, the deep and pervasive influence of the military is an essential part of the history of American science and technology policy. Scientific and technological developments have had their most significant periods of growth during and following military crises.

For example, the National Academy of Science was chartered by the Congress in 1863 to provide scientific and technical advice to the federal government as a result of the technological demands of the Civil War. A half century later, in 1916, as Europe was caught up in the carnage of World War I, President Wilson asked the Academy to establish the National Research Council. Scientists and engineers by the thousands participated in the war effort which followed.

More recently, the outbreak of World War II led Vannevar Bush of MIT to offer to President Roosevelt -- on behalf of the scientific and engineering communities -- their energies and expertise in support of the military. The President speedily accepted the offer and the Office of Scientific Research and Development was established to work closely with the military services and industry. In the years following, the scientific and engineering communities made significant contributions to the Allied victory.

As important as were these contributions to victory, their more important results were less direct but more fundamental. In a very real way, as James Crowther and others have noted, 1939-1940 marked a period in time when the role of science in human life, and the way science itself is conducted, changed sharply.

The conduct of science on a very large scale began -- and science and technology were lifted permanently into the upper councils of government because they were seen as crucial to effective economic performance and national security. It is no accident that the issue of how to use science and technology more effectively was just as important on the agendas of Presidents Truman and Eisenhower and the 79th-85th Congresses as it is on the agendas of President Bush and the 101st Congress.

TOTAL NATIONAL SUPPORT OF R&D

There are numerous ways to portray total U.S. national R&D efforts. In this brief overview, I will touch on several.

Point 1: Figures 1 and 1A show that the total annual investment in R&D has increased more than five-fold in real terms



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between 1953 and 1988; (see the constant 1982 dollar column in figure 1). The current dollar numbers look much larger but, of course, include the effects of inflation.

Point 2: The "Federal Total" and "Non-Federal Total" columns in Figure 1 show their respective percentages over time, as does the chart in Figure 1B. The Federal share was as high as two-thirds during the 1960s but appears to have stabilized at a little less than 50 percent during the past fifteen years.

Point 3: The "Defense-Related" share of the federal and national totals peaked in the early 1960s, declined significantly until 1980, then began to rise rapidly. Currenty, this category constitutes about one-third of the "National Total" about about two-thirds of the "Federal Total" investment in R&D.

Point 4: The data in Figure 1C show U.S. private sector support for R&D doubled (in real terms) between 1953 and 1963, grew at a slower rate until the first half of the 1970s, and then picked up steam during the late 1970s, until the mid-1980s. More recently, another slowdown seems to be underway. This slowdown has been highlighted in surveys such as Business Week's annual R&D review as well as NSF reports.

Point 5: There is no doubt that we are talking about large amounts of money being invested in R&D. However, these amounts cannot be examined in isolation. For example, the large and growing size of the U.S. economy results in R&D expenditures larger than those of other individual countries. But when we make a number of international comparison, there arises some cause for concern.

Point 6: Figures 1 and 1A reveal another important fact: The "Constant Dollar" column in Figure 1 and the chart in

Figure 1A show there was no real growth in national R&D investment between 1968 and 1977; indeed, there was a three percent decline.

NOTE: While the U.S. was experiencing a real decline in our R&D investment, our major economic competitors were achieving substantial, sustained growth in their R&D investment. At the beginning of the 1970s, total U.S. R&D was twice that of France, Japan, the United Kingdom and West Germany combined. By the mid-1980s, the combined R&D total of these countries nearly equalled that of the U.S.

Point 7: Table 2 shows total national R&D investment as a percentage of Gross National Product (GNP) for the U.S., France, Japan, the United Kingdom and West Germany. A brief examination of the columns shows:

- A long decline of the U.S. ratio from the mid-1960's to the late 1970s followed by a sustained rise during the 1980s;
- An erratic up and down performance by the French ratio;
- A relatively flat, uneven performance by the British ratio; and
- Steady, sustained growth in the Japanese and West German ratios.

Point 8: Table 3 shows still another dimension of comparative international performance. When defense R&D expenditures are removed from the total R&D/GNP ratio to show only civilian-related R&D, it will be no surprise to this Subcommittee that:

- The U.S. and French ratios drop sharply because of the significant shares of defense R&D in their national totals.

• The Japanese and German ratios drop barely at all due to the fact that neither country supports much defense R&D.

TRENDS IN FEDERAL SUPPORT OF R&D

Total federal support of R&D by major function is shown for Fiscal Years 1967-1989 in Figures 4 and 5 in table format. The data for 1979-1989 are shown in graph form in Figure 6. Federal support of basic research is shown in Figure 7 (table format) and Figure 8 (graph form).

Point 1: Although the data for the early postwar years are not complete, our tables and charts underscore an important feature of federal support of R&D which continues to the present day: defense-related R&D has predominated consistently in the resource allocation process during the post-World War II years.

Point 2: The data in Figures 4 and 5 show that since 1967 -- except for the 1975-1980 period -- defense R&D has accounted for fifty percent or more of federal R&D support. Currently, it represents about two-thirds of the total, as noted earlier.

Point 3: Clearly, priorities have changed over time during the past half century. For example, in 1940 -- just before the World War II buildup began -- agricultural research accounted for about thirty percent of federal R&D support -- out of a total of about $100 million. Today, agricultural research is slightly over one percent. Defense R&D represented about one-third of the total in 1940 -- or about the same level as agriculture. Health research was miniscule in 1940 compared to about 13 percent of the federal R&D total today.

Point 4: Since 1981, spending for defense-related R&D has grown dramatically faster than any other category of R&D as Figure 6 shows. Indeed, some civilian categories have declined.

Moreover, defense R&D has also grown at a faster rate than overall defense spending. Several important features of this R&D buildup will be discussed in the next section.

Point 5: The data in Figures 7 and 8 show that federal support for basic research has been substantially increased in current dollars since the late 1970s -- with health and general science leading the way. Defense support of basic research ranks fourth in functional totals.

TRENDS IN DEFENSE R&D

Since others, notably the Defense Science Board and the Office of Technology Assessment (OTA), have thoroughly examined defense-related R&D during the past two years, today I will only highlight a few key issues as we see them. Figures 9 through 12 illustrate several of these which are primarily related to DOD's "Technology Base" activities.

Point 1: As is noted in OTA's March 1988 report on "The Defense Technology Base," there are some definitional problems in discussing this topic. Strictly speaking, the Office of the Secretary of Defense has defined the "technology base programs" as consisting of Programs 6.1 (basic research) and 6.2 (exploratory development). The Office of the Secretary of Defense (OSD) has further defined science and technology programs as including technology base programs along with Program 6.3A (advanced technology development).

However, these definitions are often used interchangeably and, as the OTA observes, in recent years common usage has been to refer to 6.1, 6.2 and 6.3A as "technology base programs." Another important issue -- part definitional and part policy --

is how to treat the SDI Program: some include it as part of the technology base programs while others claim this is not proper due to its strong developmental focus and its association with anti-ballistic missile warfare.

In my review I will show defense-related R&D in several ways, using the range of definitions noted above.

Point 2: Figure 9 presents DOD constant 1982 dollar data comparing RDT&E with technology base programs -- based on Programs 6.1, 6.2 and 6.3A. Beginning in 1985, the SDI is shown as a separate component of the technology base programs. The chart reveals the following:

- From 1970 to 1980, there was no real growth in RDT&E; on the contrary, there was about a ten percent decline. Then the substantial real growth of the Reagan years led to a doubling by 1987 before levelling off occurred.

- The technology base programs were essentially flat for most of the 1970s. A very modest growth began in the late 1970s which continued to the mid-1980s before levelling off. However, the growth by no means resembles that of the RDT&E -- unless the SDI is included, which takes me to my next item.

- The "lion's share" of technology base growth during the 1980s is associated with the SDI. If SDI is included, then the technology base -- like the RDT&E -- doubled in real growth during the 1980s.

Point 3: However, another way to show the technology base programs is to use the strict OSD definition, including only 6.1 and 6.2 programs. This approach is shown in Figure 10 which shows the "technology base" in the context of overall defense R&D from 1980 to 1988. Key points are:

- The masking effects of advanced development programs and particularly the SDI are removed.
- Exploratory development (6.2) underwent a real decline of 5 percent during the 1980s.
- Basic research (6.1) experienced a real growth of only 11 percent during the 1980s. This, as Figure 10 shows, is substantially lower than any other component of defense R&D except the 6.2 program discussed above.
- Overall, then, the technology base programs, in this framework, experienced a real decline of one percent during the 1980's.

Point 4: Figure 11 shows the history of DOD's 6.1 Program since the early 1960's both in current and constant 1988 dollars. In real terms, basic research is currently being supported at a level about 25 percent below that of the 1960s. Although there has been significant growth since the mid-1970's, basic research support has clearly not participated in the recent defense buildup to the extent that other parts of defense R&D have.

Point 5: Figure 12 shows a comparable history for DOD's 6.2 Program since the early 1960s. This chart shows an even more serious decline than for basic research.

NOTE: As a summary observation, the technology base programs (6.1 plus 6.2) represented about 25 percent of the RDT&E program in the late 1960s; today they are less than 10 percent.

Point 6: An important issue raised in the previously cited OTA report is what constitutes the more general term "defense technology base." OTA properly suggests that it involves far more than DOD's technology base programs -- however defined. Since other witnesses are discussing "dual use technologies" I

will not dwell on this point other than to say that the national technology base is an important resource for DOD. And historically, for many decades, the reverse has also been true.

CONCLUDING OBSERVATIONS

In the context of your hearing, the data in my statement raise a number of important strategic policy questions -- no matter how one may come down on any specific issue. At the risk of oversimplifying some very complex matters, I will provide a few of my own views:

(1) The long period (1967-1978) of no real growth in total U.S. R&D investment explains, in part:

- Lowered U.S. economic competitiveness as reflected in a number of measures, not the least of which is the massive trade defict.
- Lower U.S. manufacturing productivity than in Japan and West Germany.

(2) The U.S. R&D investment strategy of those years (1967-1978) contrasts sharply and negatively with the strategies followed by our principal economic competitors: substantial, sustained R&D investment.

(3) The current slowdowns both in public and private U.S. R&D investment are even more troubling. We can't go back and change what happened twenty years ago but we surely ought not to repeat our mistakes. Cutting back on R&D for short-term purposes is not the strategy for improving our economic strength in the future. We could benefit from paying more attention to the strategies of our competitors.

(4) Flows and transfers from U.S. defense technology to the

civilian sector have become less certain and less influential in recent years than they were in earlier decades. Much more anlysis is required in this area to understand with greater precision what is happening in various scientific and technical areas.

(5) Nevertheless, the "substantial, sustained commitment" strategy of Japan and West Germany for investing in civilian R&D has, I think, given them a vital competitive edge.

(6) Whatever the overall impact of defense R&D on the national economy, I think we must be deeply concerned about the long, downward trend in DOD's technology base as defined by 6.1 and 6.2 programs. Further, these are areas in which there is the strongest likelihood of payoffs in the civilian sector.

(7) The downward trend in the defense technology base also raises an issue which I hope will not be taken as the parochial concern of a university person. The Defense Department draws upon the national technology base and the nation's educational system in conducting its missions. I do not think it unreasonable to raise the question of whether the DOD is providing its "fair share."

(8) Finally, I would hope that the budget crunch that you will be struggling with in coming months will not lead to proportionate cuts in the defense technology base programs along with whatever cuts may be made in the defense budget. These programs did not share in the increases of the 1980s.

FIGURE 1

Trends in Federal and Non-Federal R&D Outlays: 1953 and 1960-89

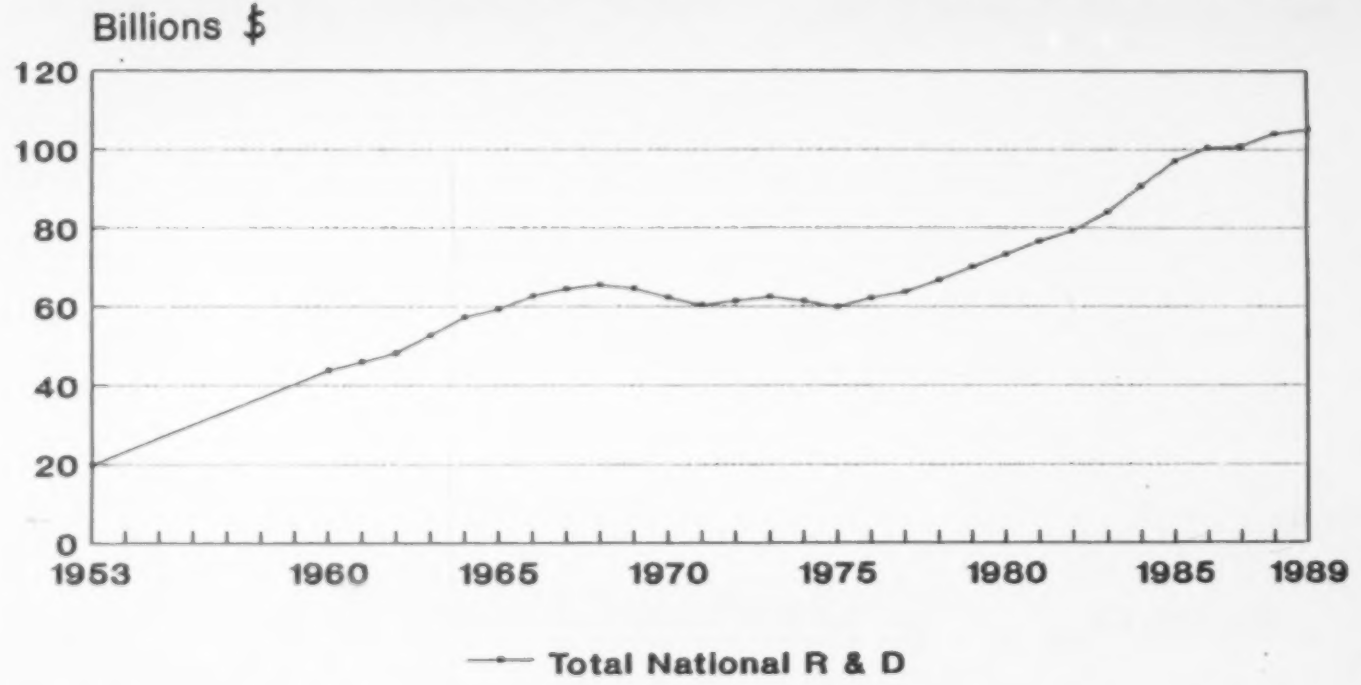
(Percents) (Millions of Dollars)

| Year | Federal | | | | Non-Federal | Total National (Constant Dollars) (1982) | Total National (Current Dollars) |
|---|---|---|---|---|---|---|---|
| | Total | Defense Related | Space Related | Civilian Related | | | |
| 1953 | 54 | 48 | 1 | 5 | 46 | $19,744 | $5,124 |
| 1960 | 65 | 52 | 3 | 9 | 35 | $43,648 | $13,523 |
| 1961 | 65 | 50 | 6 | 9 | 35 | $45,764 | $14,316 |
| 1962 | 64 | 48 | 7 | 9 | 36 | $48,176 | $15,394 |
| 1963 | 66 | 41 | 14 | 11 | 34 | $52,585 | $17,059 |
| 1964 | 66 | 37 | 19 | 9 | 34 | $57,202 | $18,854 |
| 1965 | 65 | 33 | 21 | 11 | 35 | $59,351 | $20,044 |
| 1966 | 64 | 33 | 19 | 12 | 36 | $62,589 | $21,846 |
| 1967 | 62 | 35 | 14 | 13 | 38 | $64,406 | $23,146 |
| 1968 | 61 | 35 | 13 | 13 | 39 | $65,458 | $24,605 |
| 1969 | 58 | 34 | 11 | 13 | 42 | $64,672 | $25,631 |
| 1970 | 57 | 33 | 10 | 14 | 43 | $62,405 | $26,134 |
| 1971 | 56 | 32 | 9 | 15 | 44 | $60,385 | $25,676 |
| 1972 | 56 | 32 | 9 | 15 | 44 | $61,414 | $28,477 |
| 1973 | 53 | 30 | 8 | 15 | 47 | $62,427 | $30,718 |
| 1974 | 51 | 27 | 8 | 16 | 49 | $61,467 | $32,864 |
| 1975 | 51 | 26 | 8 | 17 | 49 | $59,883 | $35,213 |
| 1976 | 51 | 26 | 8 | 17 | 49 | $62,134 | $39,018 |
| 1977 | 50 | 26 | 8 | 17 | 50 | $63,653 | $42,783 |
| 1978 | 50 | 25 | 6 | 19 | 50 | $66,769 | $48,129 |
| 1979 | 49 | 23 | 6 | 19 | 51 | $70,077 | $54,933 |
| 1980 | 47 | 22 | 6 | 9 | 53 | $73,235 | $62,593 |
| 1981 | 46 | 24 | 5 | 7 | 54 | $76,610 | $71,840 |
| 1982 | 46 | 26 | 4 | 6 | 54 | $79,364 | $79,316 |
| 1983 | 47 | 28 | 4 | 5 | 53 | $83,964 | $87,204 |
| 1984 | 46 | 30 | 3 | 3 | 54 | $90,684 | $97,638 |
| 1985 | 48 | 32 | 3 | 13 | 52 | $96,999 | $107,757 |
| 1986 | 48 | 33 | 3 | 12 | 52 | $100,398 | $112,497 |
| 1987 | 48 | 34 | 3 | 12 | 52 | $100,823 | $118,782 |
| 1988 est | 47 | 33 | 3 | 12 | 53 | $103,941 | $126,115 |
| 1989 est | 47 | 32 | 3 | 12 | 53 | $105,029 | $132,350 |

NOTE: Detail may not add to 100 percent because of rounding
SOURCE: National Science Foundation

# FIGURE 1A

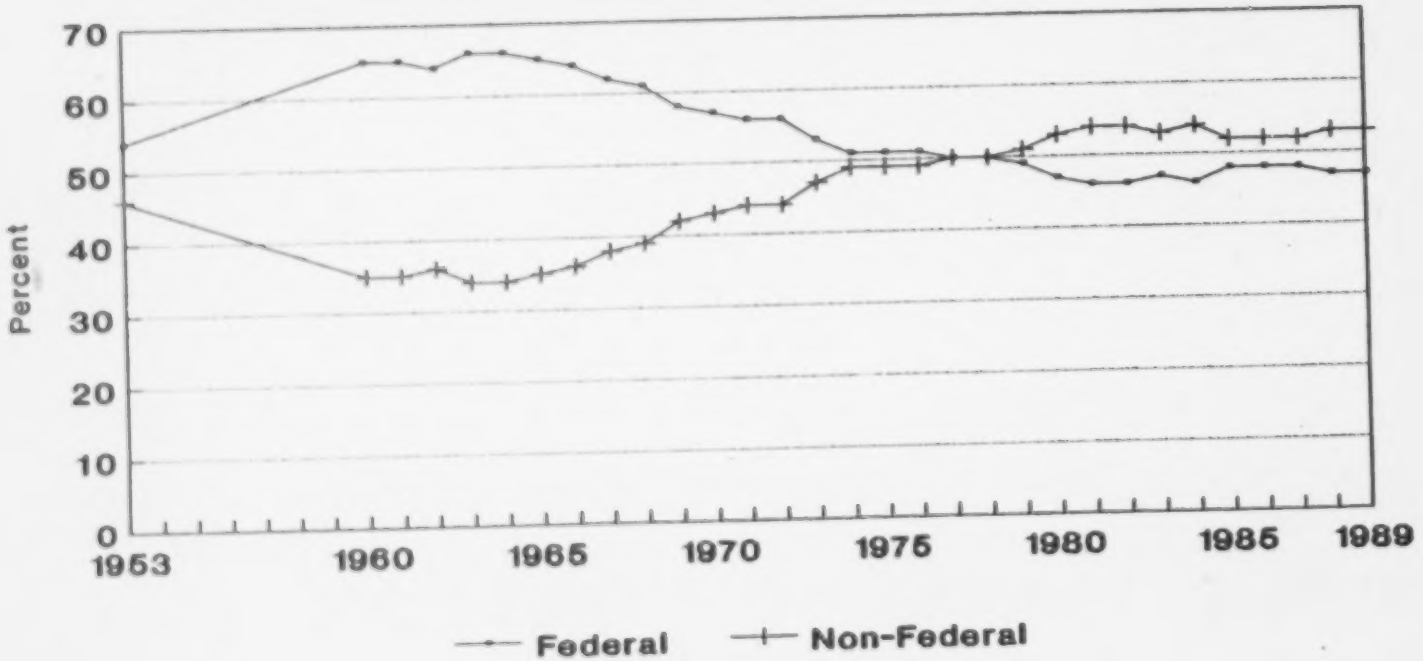
## Total National R & D - Constant $ 1982




Source: N.S.F.

# FIGURE 1B

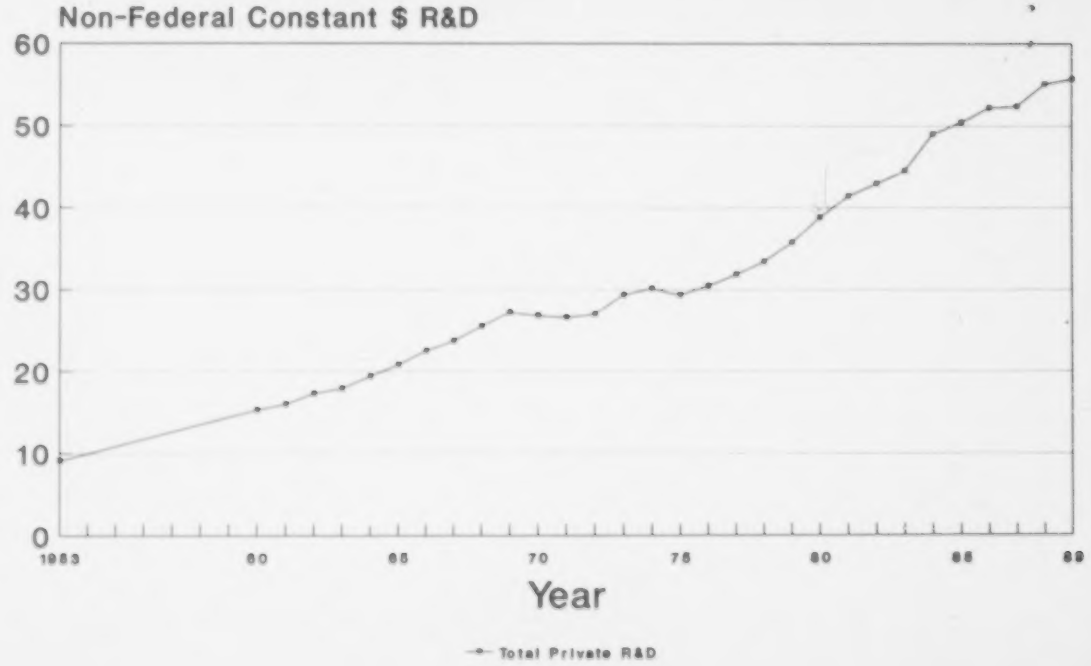
## Federal & Non-Federal R & D Outlays




Source: N.S.F.

# FIGURE 1C

## Private R&D Outlays - Constant $ 1982




Source: N.S.F.

# FIGURE 2 - National Expenditures for Performance of R & D as Percent of GNP by Country 1961-87

| Year | France | West Germany | Japan | United Kingdom | United States |
|---|---|---|---|---|---|
| 1961 | 1.4 | NA | 1.4 | 2.5 | 2.7 |
| 1962 | 1.5 | 1.4 | 1.5 | NA | 2.7 |
| 1963 | 1.6 | 1.4 | 1.4 | NA | 2.8 |
| 1964 | 1.8 | 1.6 | 1.5 | 2.3 | 2.9 |
| 1965 | 2.0 | 1.7 | 1.5 | NA | 2.8 |
| 1966 | 2.0 | 1.8 | 1.5 | 2.3 | 2.8 |
| 1967 | 2.1 | 2.0 | 1.6 | 2.3 | 2.8 |
| 1968 | 2.1 | 2.0 | 1.7 | 2.2 | 2.8 |
| 1969 | 1.9 | 1.8 | 1.7 | 2.3 | 2.7 |
| 1970 | 1.9 | 2.0 | 1.9 | NA | 2.6 |
| 1971 | 1.9 | 2.2 | 1.9 | NA | 2.4 |
| 1972 | 1.9 | 2.2 | 1.9 | 2.1 | 2.3 |
| 1973 | 1.8 | 2.1 | 2.0 | NA | 2.3 |
| 1974 | 1.8 | 2.1 | 2.0 | NA | 2.2 |
| 1975 | 1.8 | 2.2 | 2.0 | 2.1 | 2.2 |
| 1976 | 1.8 | 2.1 | 2.0 | NA | 2.2 |
| 1977 | 1.8 | 2.1 | 2.0 | NA | 2.1 |
| 1978 | 1.8 | 2.2 | 2.0 | 2.2 | 2.1 |
| 1979 | 1.8 | 2.4 | 2.1 | NA | 2.2 |
| 1980 | 1.8 | 2.4 | 2.2 | NA | 2.3 |
| 1981 | 2.0 | 2.5 | 2.3 | 2.4 | 2.4 |
| 1982 | 2.1 | 2.6 | 2.4 | NA | 2.6 |
| 1983 | 2.1 | 2.6 | 2.6 | 2.2 | 2.6 |
| 1984 | 2.2 | 2.6 | 2.6 | NA | 2.6 |
| 1985 | 2.3 | 2.8 | 2.8 | 2.3 | 2.7 |
| 1986 | 2.3 | 2.7 | 2.8 | 2.4 | 2.7 |
| 1987 | 2.3 | 2.7 | 2.8 | NA | 2.6 |

Source: N.S.F., O.E.C.D.

# FIGURE 3 - Estimated Ratio of Civilian R & D Expenditures to GNP for Selected Countries 1967-87

| Year | France | West Germany | Japan | United Kingdom | United States |
|---|---|---|---|---|---|
| 1967 | NA | NA | 1.5 | NA | 1.9 |
| 1968 | NA | 1.8 | 1.9 | NA | 1.8 |
| 1969 | NA | 1.9 | 1.8 | NA | 1.8 |
| 1970 | NA | 2.0 | 1.8 | NA | 1.8 |
| 1971 | 1.5 | 2.0 | 1.9 | NA | 1.6 |
| 1972 | 1.5 | 2.1 | 1.9 | 1.5 | 1.6 |
| 1973 | 1.4 | 1.9 | 2.0 | NA | 1.6 |
| 1974 | 1.4 | 2.0 | 2.0 | NA | 1.6 |
| 1975 | 1.5 | 2.1 | 2.0 | 1.5 | 1.6 |
| 1976 | 1.4 | 2.0 | 2.0 | NA | 1.6 |
| 1977 | 1.4 | 2.0 | 2.0 | NA | 1.6 |
| 1978 | 1.4 | 2.1 | 2.0 | 1.6 | 1.6 |
| 1979 | 1.4 | 2.3 | 2.1 | NA | 1.7 |
| 1980 | 1.4 | 2.3 | 2.2 | NA | 1.8 |
| 1981 | 1.5 | 2.4 | 2.3 | 1.7 | 1.8 |
| 1982 | 1.6 | 2.5 | 2.3 | 1.7 | 1.8 |
| 1983 | 1.7 | 2.5 | 2.5 | 1.6 | 1.9 |
| 1984 | 1.8 | 2.5 | 2.6 | NA | 1.8 |
| 1985 | NA | 2.6 | 2.8 | 1.8 | 1.8 |
| 1986 | 1.9 | 2.6 | 2.8 | 1.8 | 1.8 |
| 1987 | 1.8 | 2.6 | 2.8 | NA | 1.7 |

Sources: N.S.F., O.E.C.D.

# FIGURE 4 - Fiscal Years 1967-77
## Federal R&D Funding by Budget Function

| Function | 1967 | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $16,529 | $15,921 | $15,641 | $15,339 | $15,543 | $16,496 | $16,800 | $17,410 | $19,039 | $20,780 | $23,450 |
| National defense | 8,566 | 8,275 | 8,356 | 7,981 | 8,110 | 8,902 | 9,002 | 9,016 | 9,679 | 10,430 | 11,864 |
| Health | 915 | 1,021 | 1,088 | 1,084 | 1,288 | 1,547 | 1,585 | 2,069 | 2,170 | 2,351 | 2,629 |
| Space research and technology | 4,778 | 4,304 | 3,799 | 3,606 | 3,048 | 2,932 | 2,824 | 2,702 | 2,764 | 3,130 | 2,832 |
| General science | 409 | 437 | 433 | 452 | 513 | 625 | 658 | 749 | 813 | 858 | 974 |
| Energy | 600 | 657 | 597 | 574 | 556 | 574 | 630 | 759 | 1,363 | 1,649 | 2,362 |
| Natural resources and environment | 320 | 331 | 323 | 340 | 416 | 479 | 554 | 516 | 624 | 683 | 753 |
| Transportation | 380 | 304 | 404 | 535 | 728 | 556 | 572 | 693 | 635 | 631 | 708 |
| Agriculture | 218 | 217 | 221 | 238 | 259 | 294 | 308 | 313 | 342 | 383 | 457 |
| International affairs | 18 | 17 | 26 | 32 | 32 | 29 | 28 | 24 | 29 | 42 | 66 |
| Education, training, employment and social services | 154 | 166 | 169 | 164 | 215 | 235 | 290 | 236 | 239 | 255 | 230 |
| Veterans benefits and services | 41 | 45 | 50 | 59 | 63 | 69 | 74 | 85 | 95 | 98 | 107 |
| Commerce and housing credit | 43 | 48 | 54 | 79 | 90 | 50 | 50 | 51 | 65 | 69 | 71 |
| Administration of justice | (a) | 1 | 5 | 9 | 10 | 23 | 33 | 35 | 44 | 35 | 30 |
| Community and regional development | 37 | 44 | 32 | 47 | 65 | 66 | 78 | 82 | 93 | 109 | 101 |
| Income security | 48 | 50 | 78 | 136 | 145 | 106 | 106 | 71 | 72 | 48 | 55 |
| General government | 3 | 5 | 5 | 6 | 7 | 8 | 7 | 9 | 12 | 12 | 13 |

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

(Dollars in Millions)

# FIGURE 5 - Fiscal Years 1978-89
## Federal R&D Funding by Budget Function

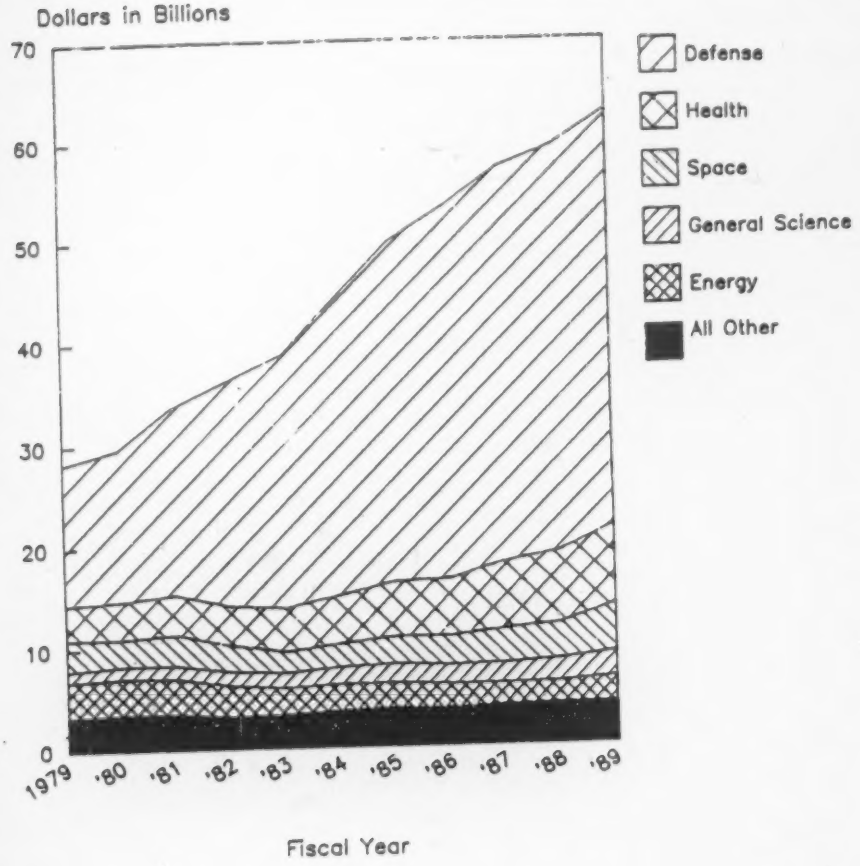
| Function | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 est | 1989 est |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $25,976 | $28,208 | $29,739 | $33,735 | $36,115 | $38,768 | $44,214 | $49,887 | $53,249 | $57,069 | $59,204 | $62,892 |
| National defense | 12,899 | 13,791 | 14,946 | 18,413 | 22,070 | 24,936 | 29,287 | 33,698 | 36,926 | 39,152 | 40,300 | 41,318 |
| Health | 2,968 | 3,401 | 3,694 | 3,871 | 3,869 | 4,298 | 4,779 | 5,418 | 5,565 | 6,556 | 7,087 | 7,849 |
| Space research and technology | 2,939 | 3,136 | 2,738 | 3,111 | 2,584 | 2,134 | 2,300 | 2,725 | 2,894 | 3,398 | 3,574 | 4,733 |
| General science | 1,050 | 1,119 | 1,233 | 1,340 | 1,359 | 1,502 | 1,676 | 1,862 | 1,873 | 2,042 | 2,150 | 2,533 |
| Energy | 3.134 | 3,461 | 3,603 | 3.501 | 3,012 | 2,578 | 2,581 | 2,389 | 2,286 | 2,053 | 2,126 | 2,671 |
| Transportation | 768 | 798 | 887 | 869 | 791 | 876 | 1,048 | 1,038 | 917 | 908 | 918 | 1,064 |
| Natural resources and environment | 904 | 1,010 | 999 | 1,061 | 965 | 952 | 963 | 1,059 | 1,062 | 1,133 | 1,163 | 1,061 |
| Agriculture | 501 | 552 | 585 | 659 | 693 | 745 | 762 | 836 | 815 | 822 | 876 | 850 |
| Education, training, employment and social services | 345 | 354 | 468 | 298 | 228 | 189 | 200 | 220 | 248 | 267 | 290 | 295 |
| Veterans benefits and services | 111 | 123 | 126 | 143 | 139 | 157 | 218 | 193 | 183 | 215 | 210 | 206 |
| International affairs | 57 | 117 | 125 | 160 | 165 | 177 | 192 | 210 | 211 | 223 | 208 | 199 |
| Commerce and housing credit | 77 | 93 | 101 | 106 | 104 | 107 | 110 | 114 | 111 | 110 | 121 | 131 |
| Community and regional development | 92 | 127 | 119 | 104 | 63 | 44 | 46 | 50 | 68 | 99 | 102 | 93 |
| Administration of justice | 44 | 47 | 45 | 34 | 31 | 37 | 24 | 47 | 41 | 49 | 43 | 55 |
| Income security | 67 | 57 | 47 | 43 | 32 | 32 | 26 | 21 | 14 | 25 | 20 | 18 |
| General government | 20 | 23 | 22 | 22 | 10 | 6 | 8 | 17 | 14 | 17 | 16 | 15 |

Note: Data for 1978-87 are shown in actual budget authority. Data for 1988 and 1989 are estimates based on the FY 1989 budget.

SOURCE: National Science Foundation, SRS

(Dollars in Millions)

# FIGURE 6
## Federal R & D by Major Function (Cumulative)




SOURCE: National Science Foundation, SRS

# FIGURE 7 - Fiscal Years 1978-89
## Budget Authority for Basic Research by Function

| Function | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 est | 1989 est |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $3,665 | $4,108 | $4,716 | $5,107 | $5,303 | $6,247 | $7,072 | $7,810 | $8,193 | $9,021 | $9,530 | $10,319 |
| Health | 1,246 | 1,579 | 1,761 | 1,951 | 1,953 | 2,475 | 2,813 | 3,243 | 3,324 | 3,851 | 4,153 | 4,253 |
| General science | 962 | 1,026 | 1,152 | 1,256 | 1,296 | 1,439 | 1,606 | 1,779 | 1,795 | 1,942 | 2,045 | 2,415 |
| Space research and technology | 412 | 440 | 482 | 445 | 434 | 501 | 646 | 498 | 737 | 843 | 849 | 1,062 |
| National defense | 320 | 365 | 552 | 610 | 696 | 788 | 845 | 856 | 960 | 900 | 907 | 924 |
| Energy | 157 | 172 | 200 | 220 | 260 | 320 | 365 | 428 | 456 | 511 | 568 | 571 |
| Agriculture | 197 | 222 | 246 | 281 | 295 | 326 | 353 | 406 | 390 | 397 | 417 | 418 |
| Transportation | 70 | 75 | 79 | 89 | 102 | 117 | 125 | 255 | 184 | 231 | 226 | 329 |
| Natural resources and environment | 207 | 131 | 136 | 131 | 139 | 156 | 192 | 206 | 204 | 206 | 217 | 208 |
| Education, training, employment and social services | 57 | 59 | 61 | 66 | 78 | 70 | 77 | 86 | 83 | 78 | 83 | 84 |
| Commerce and housing credit | 9 | 10 | 15 | 17 | 17 | 19 | 20 | 23 | 26 | 26 | 27 | 27 |
| Veterans benefits and services | 9 | 10 | 14 | 15 | 13 | 14 | 15 | 15 | 15 | 17 | 19 | 17 |
| Administration of justice | 10 | 10 | 9 | 5 | 4 | 4 | 5 | 4 | 5 | 8 | 9 | 4 |
| General government | - | (a) | (a) | 3 | 2 | 3 | 3 | 4 | 5 | 4 | 5 | 3 |
| Community and regional development | 8 | 8 | 8 | 5 | 7 | 6 | 5 | 6 | 6 | 4 | 4 | 3 |
| International affairs | (a) | - | - | 12 | 10 | 10 | 3 | 4 | 5 | 3 | 2 | 1 |
| Income security | 2 | 1 | 1 | 3 | - | - | - | - | - | - | - | - |

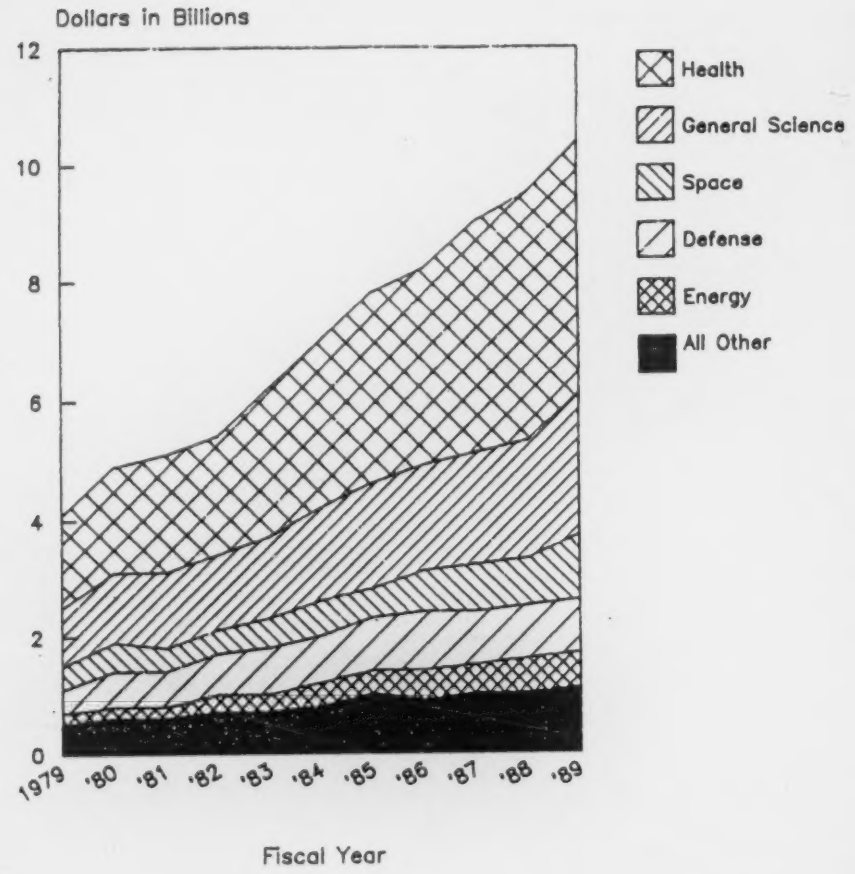
(a) Less than $500,000.

Note: Data for 1978-87 are shown in actual budget authority. Data for 1988 and 1989 are estimates based on the FY 1989 budget.

SOURCE: National Science Foundation, SRS

(Dollars in Millions) FEDERAL BASIC RESEARCH

# FIGURE 8
## Federal Basic Research by Major Function




SOURCE: National Science Foundation, SRS

# FIGURE 10 - Fiscal Years 1980-88
## R & D in the Department of the Defense

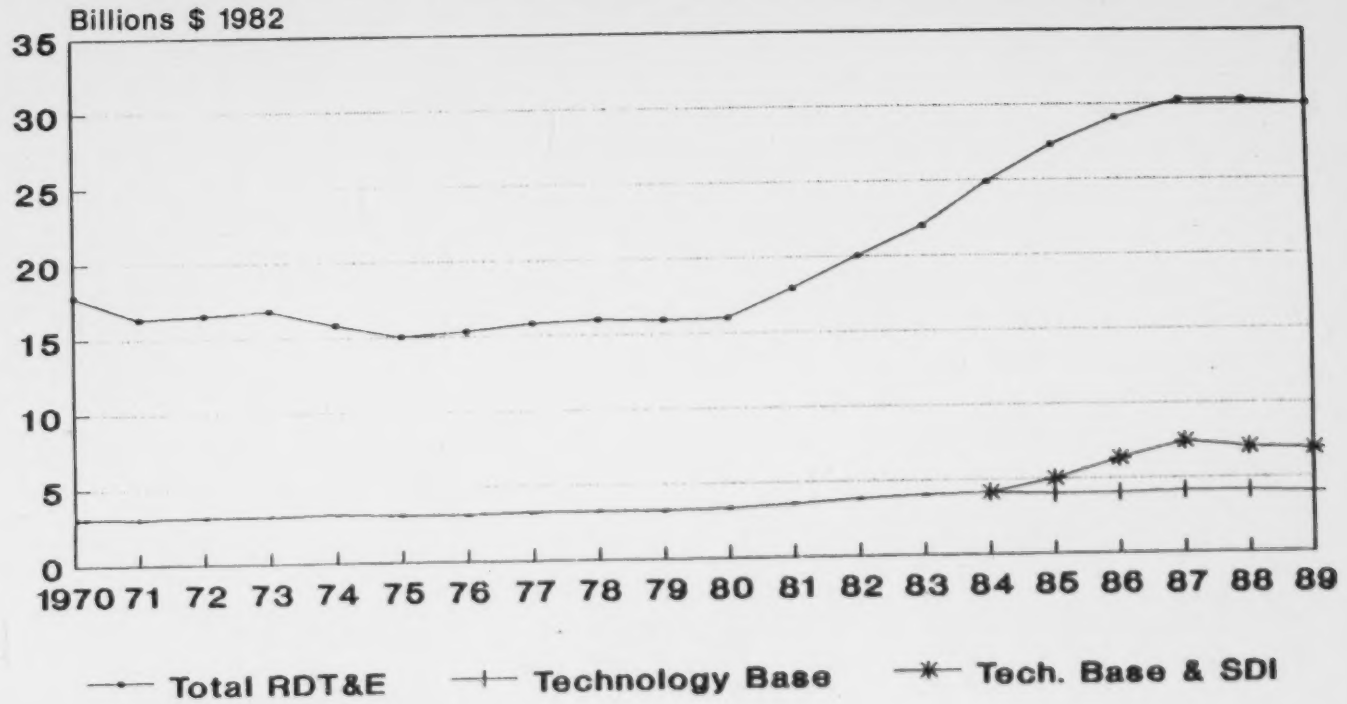
| | FY 1980 | FY 1981 | FY 1982 | FY 1983 | FY 1984 | FY 1985 | FY 1986 | FY 1987 | FY 1988 | Percent Change FY 1980-88 Curr. | Const. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Research, development, test and evaluation: | | | | | | | | | | | |
| Research (6.1 category) | $552 | $615 | $697 | $787 | $843 | $851 | $954 | $894 | $901 | 63% | 11% |
| Exploratory development | 1,712 | 1,985 | 2,235 | 2,451 | 2,212 | 2,259 | 2,279 | 2,343 | 2,392 | 40% | -5% |
| Technology base | 2,265 | 2,600 | 2,933 | 3,238 | 3,055 | 3,110 | 3,232 | 3,237 | 3,294 | 45% | -1% |
| Advanced technology development | 604 | 593 | 751 | 823 | 1,352 | 2,745 | 4,067 | 5,032 | 5,434 | 799% | 510% |
| Strategic programs | 2,188 | 3,440 | 4,636 | 5,825 | 7,878 | 8,136 | 7,509 | 7,703 | 7,391 | 238% | 129% |
| Tactical programs | 5,313 | 6,130 | 6,890 | 7,255 | 7,929 | 9,007 | 10,266 | 11,032 | 12,212 | 130% | 56% |
| Intelligence and communications programs | 1,428 | 1,632 | 2,160 | 2,709 | 3,406 | 3,941 | 4,525 | 4,702 | 4,882 | 333% | 193% |
| Defense-wide mission support | 1,996 | 2,238 | 2,733 | 2,975 | 3,318 | 3,799 | 4,077 | 4,236 | 4,051 | 103% | 38% |
| Adjustments | 0 | 0 | 0 | 0 | 0 | -172 | 0 | 0 | 0 | 0% | 0% |
| TOTAL RDT&E | 13,495 | 16,634 | 20,103 | 22,825 | 26,938 | 30,566 | 33,676 | 35,941 | 37,263 | 176% | 87% |
| Other appropriations [1] | 526 | 729 | 746 | 848 | 997 | 1412 | 1324 | 1194 | 893 | 70% | 15% |
| TOTAL DOD R&D | $14,021 | $17,363 | $20,848 | $23,673 | $27,935 | $31,978 | $35,000 | $37,136 | $38,156 | 172% | 84% |
| President's Request | | 17,322 | 22,059 | 25,107 | 30,518 | 35,336 | 40,669 | 43,323 | 45,071 | | |
| Percent Change: Appropriations v. Request | | 0% | -5% | -6% | -8% | -10% | -14% | -14% | -15% | -11% | |

Source: AAAS Reports VI - XIII for actual budget authority for FY 1980 - FY 1988, and "OMB Special Analysis J, FY 1989" for estimated budget authority for FY 1988.

(budget authority in millions)

# FIGURE 9

## Comparison of RDT&E and Technology Base

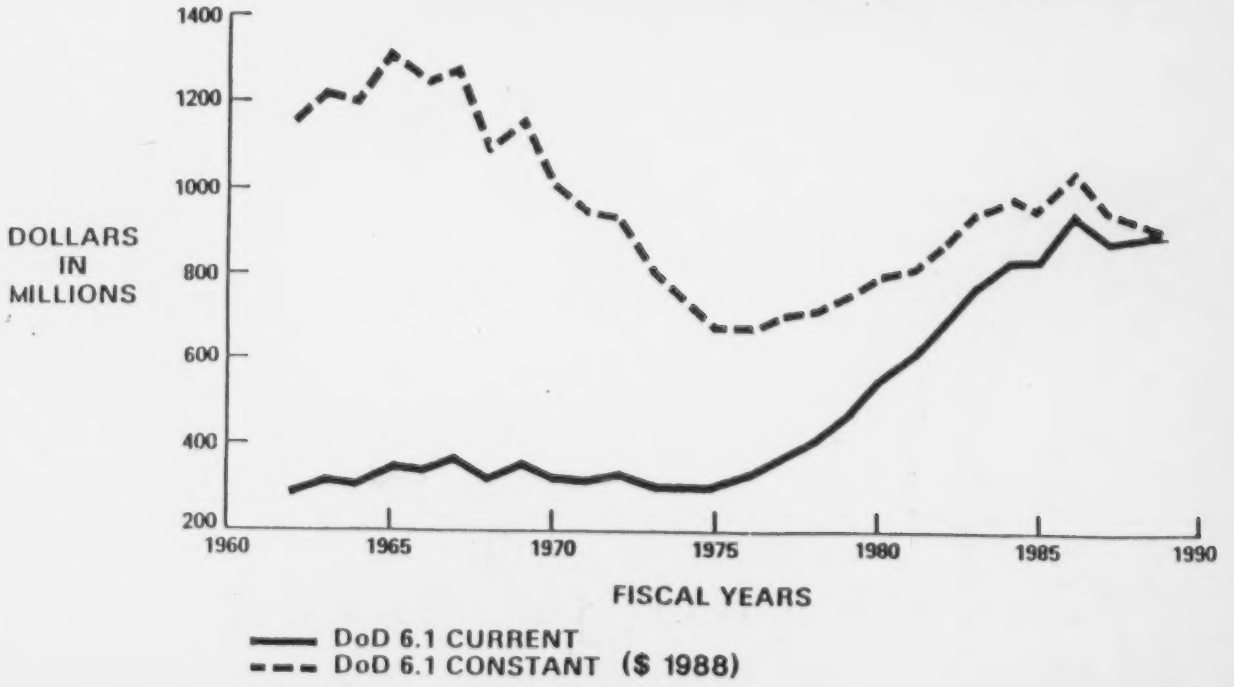



Data provided by OSD (Billions 1982$)

# FIGURE 11

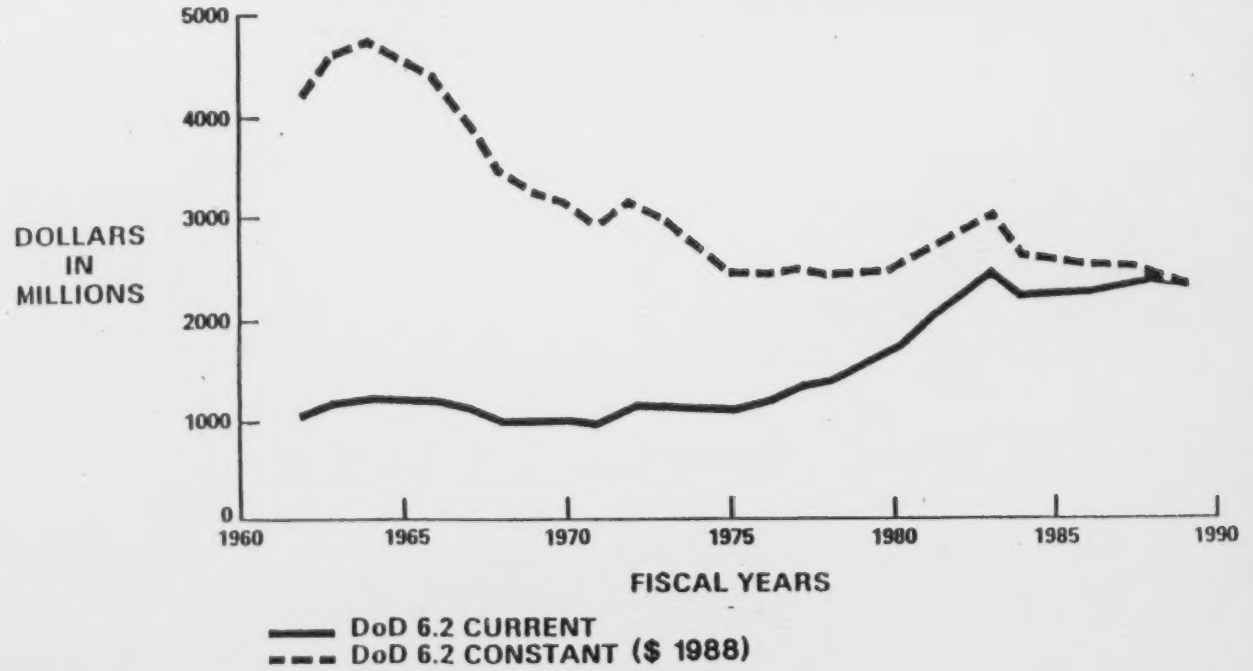
## Science and Technology Trend

### IN CURRENT AND CONSTANT DOLLARS



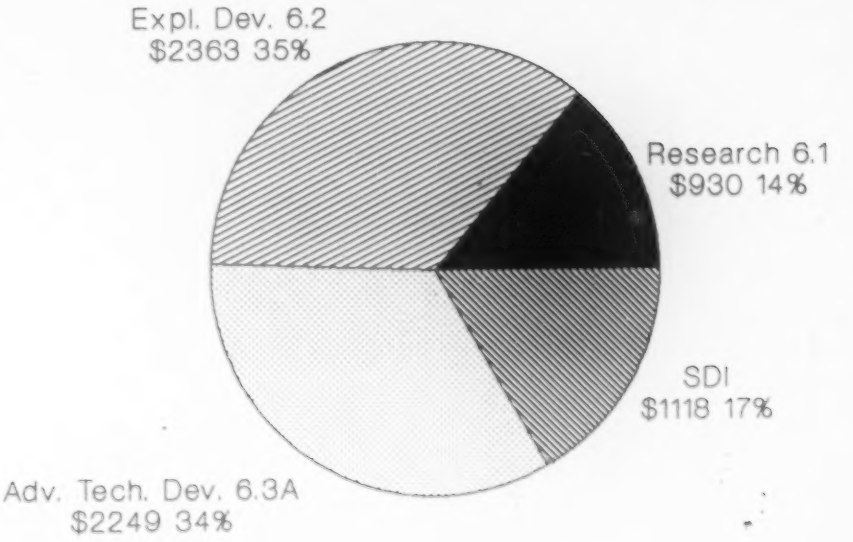

Source: DoD

# FIGURE 12
## Science and Technology Trend
### IN CURRENT AND CONSTANT DOLLARS



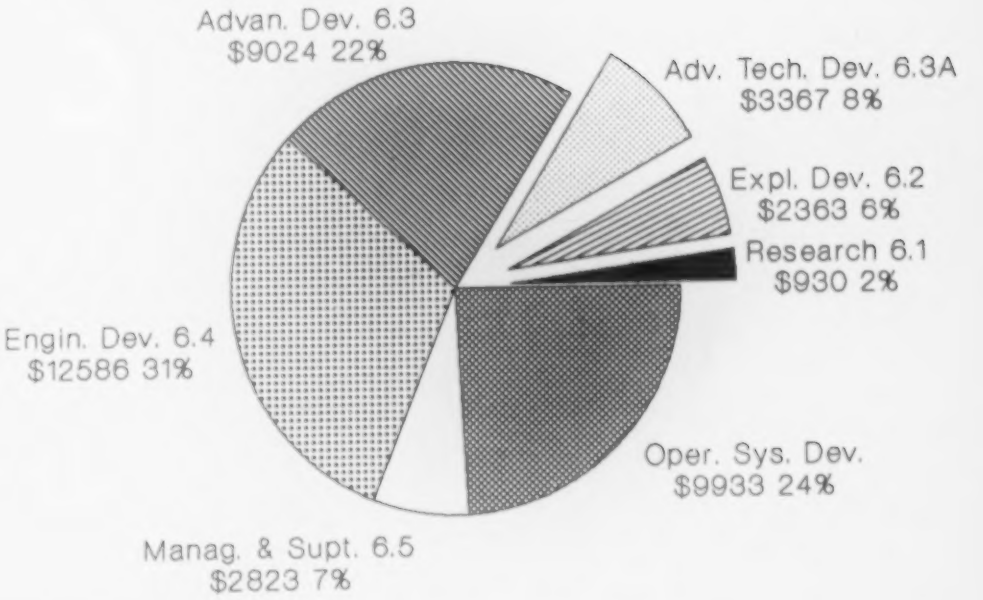

Source: DoD

# Tech Base by Category
## FY 1990 ($ millions)




Data provided by DOD

# RDT&E by Category
## FY1990 ($ millions)




**Data provided by DOD, Total $ 41,025**

Mr. DARDEN. Thank you very much. We appreciate your testimony, Dr. Langenberg.

Our next witness, our third witness, is Dr. James Colvard. Thank you very much for being here, Dr. Colvard, and would you please proceed with your testimony.

**STATEMENT OF JAMES E. COLVARD, ASSOCIATE DIRECTOR AND PRINCIPAL PROFESSIONAL STAFF, APPLIED PHYSICS LABORATORY**

Mr. COLVARD. Thank you, Mr. Chairman. I am pleased to be here today.

I have submitted some remarks to the committee for the record. I would choose to deviate from those a little bit and simply summarize a few points and then get on to a question-and-answer session.

I think one of the most critical things about military R&D is the recognition that it is a very complex process. It involves a multiplicity of players and today we operate in a society that is drastically different than any other period in our history.

Since World War II, with the advent of nuclear weapons and the come-as-you-are war syndrome, we have developed a military industry that has no purpose other than developing military weapons for the first time in the history of the country. It has a major impact on our economy, so the nature of this process has become inherently political. We have no choice but to treat it that way.

It is a special business. We tend oft-times to treat it as if it were a purchasing of consumables and could be managed as other businesses that we are familiar with are managed, but it is significantly different. I think we have to be mindful of that.

The significant difference is that there is no way to measure the consequence of failure. If we fail in a free-market business enterprise, it may cost the taxpayer—or the stockholders money, but if we fail in a military R&D endeavor, it may or may not have a consequence depending on whether or not we fight a war. If we do have a consequence, it may be too late to recover from it.

The players involved are multiple, as I said. The first player, and the final player, is the military. They, like all the other players, have both higher and lower motivations. The higher motivation of the military is to properly provide for the defense of the country, to carry out their portion of the national defense mission. Like all of us, their lower motive is to optimize around their service.

The R&D communities, and there are multiple R&D communities, have their motives. The higher motive is to better understand the laws of nature and apply those in providing weapons for the defense of the country. Their lower motive, of course, is to get their share of the business. That community includes the universities that generate the engineers and scientists that we need. They involve the R&D centers, both within the services and those associated with universities, and of course, they involve industry and their laboratories.

Then a major player in this equation, particularly critical in a free-market, democratic process, is the industrial base. We often treat the industrial base, and certainly in the last several years, as if somehow they are the enemy. It is they who must take the ideas

that the scientists and engineers say that the laws of physics will permit, that the military officers say that they need, and translate those into useful form. Yet, we have created a situation in which we ascribe to them nothing but the lower motive; that is, to make a profit, rather than the higher motive that they have which is to produce a useful product and to make their contribution to the national defense.

We have an intermediate group, the program managers, who have to connect this process. Theirs is, in many respects, the most difficult role of all because they neither have the truth and beauty of the science nor the form of the engineer, but in fact, have responsibility for making the whole mess work. We often give them less authority and more accountability or more responsibility than is functionally useful.

Last, of course, is the Congress. The Congress has to authorize the expenditure of funds, reflecting in its higher purpose, the will of the people; reflecting in its lower purpose the desire to get reelected.

The key in this whole process of trying to bring together a complex number of players in a very critical business is an understanding in depth at all the levels. We have to have military officers that understand the art and craft of war. They must be involved in the acquisition process. It is not, in my opinion, reasonable to suggest that we can have a separate acquisition corps that does not have the military as a dominant player.

The people who are going to take the weapons of war to war and fight with them have to be involved in specifying them.

We have to have scientists and engineers who understand what the options are, what the laws of nature will permit, before we make decisions to buy. Once we have made the decision to buy, it becomes a purely political process. It is very difficult to turn off a major acquisition for all kinds of reasons. We must conduct the critical experiments early on within the confines of organizations whose purpose is to determine what physical truth is with little or no motivation of making a profit from producing the weapon.

We oft-times make the decision to go to acquisition too soon because we have not looked at the options; we have run the critical experiments. It is cheap to fail early on because you can make mistakes in R&D and, in fact, this is where you should make your critical decisions. It is very expensive to fail after you have gone into production. You cannot substitute for that understanding, testing at the end. It is not possible to test quality into a product. You simply must do the testing as you go along. You must have knowledgeable people who understand it.

There is a philosophy that argues you must build a little, test a little, learn a lot, and at each intermediate stage, you must determine whether it is appropriate to proceed to the next stage.

The complexity of the systems that we are dealing with are such that if you don't do the testing at the early and intermediate stages, it is extremely difficult to unravel the cause of the problems when you get to the end product.

We have to recognize also that the critical role of R&D is not only to produce options and advance understanding of the laws of

physics and nature, but to produce qualified people who participate in this process.

I talked about the program managers who are connecting links. Quite often, in a democratic process such as ours, with a free-market economy, we get enamored of the idea that if we could optimize the connecting link between science and engineering and industry, that somehow this would solve the problems, so we tend to argue that we will develop acquisition corps. The implication of these discussions center around the idea that those people who are administrators and understand the laws of the process can somehow make it right. It is, in my opinion, fallacious reasoning to follow that path.

The critical people in that connecting process, in my view, are the military and the engineers. The scientists will produce ideas, but it the ability to connect those ideas with useful reality that is the critical dimension and we do not frequently enough train those engineers in the experiential art of doing and then keep them in the process until the program has been completed. We tend to involve them in a tech base; we tend to generate ideas and then we turn it over to people who have long been away from the field of science and engineering to administer and the connectivity between the reality permitted by science and engineering and the need for the military, using our industrial base to produce it, gets lost.

In response to your question about the Japanese, Congressman Dickinson, it is my opinion that, as an international power, we cannot hide technology. In my opinion, we must create an environment where you simply out-innovate the people. You cannot deny them the technology as an international organization; they will find it sooner or later.

I heard Admiral Inman expound on this when he was at the CIA and somebody asked about increasing the secrecy of our operations. If there is any one lesson I think I have learned in 30 years of working in the R&D business, it is that people will not keep ideas to themselves; that we must create an environment where our people are encouraged to generate the ideas and simply beat them in that fashion.

Let me summarize my remarks by saying that, as I opened, it is a very, very complex business. We are tempted too often to solve the problems that occur in this business by mandating solutions to problems that are popular at the moment. A few years ago, we were very carried away with the idea that if we tested better, things would be better. We get carried away with single-function advocates, who advocate for example, more competition. Competition will only guarantee you one thing, competition. It will not guarantee you a workable product.

If you don't understand what is technically possible to do and what industry can produce, competing it will not get you anywhere. We get carried away with the idea that if we simplified our specifications and we just said, "Industry, here is what we need," that somehow that would solve it. You can go on and on on the single-function advocates that take this complex process that is, in my opinion, a continuum from the need as envisioned by the warfighter, as deemed to be permissible by the scientists and engineers

who understand the laws of physics as can be produced by our industrial base and then ultimately used by the military officer.

There is no greater accountability in that process than the fact that the person who is going to have to use the weapon and stake their life on it first is the person who is involved in defining it.

Thank you.

PREPARED STATEMENT OF DR. JAMES E. COLVARD

I want to thank the chairman for asking me to be here and I am honored to be associated with such men of distinction as the other two members of this panel. I commend the chairman and the committee for taking a basic and conceptual view of the defense research and development process. We tend to get so caught up in procedures that we often lose sight of our basic purpose. I have spent some thirty years in the DoD R&D business and am pleased to submit the following brief thoughts on the subject.

Since World War II our national defense posture has permanently changed and this change has profoundly affected our institutions, our people, and our processes. Until World War II we were a militia nation which armed when attacked, fought, won, and then disarmed--to repeat the cycle when threatened or attacked again. Since World War II we have become a nation constantly preparing for war but which has actually fought only limited, undeclared wars. On the one hand, this constant readiness has created a defense industry as an important part of our economy. On the other, the limited nature of war since World War II has diminished our experiential understanding of the art of war.

As a result of the first condition the defense process has become more political. We are no longer urgently arming to respond to an imminent danger, but rather are sustaining preparedness against a potential threat. This allows more time for debate, but also allows paths to be followed that may be more politically expedient than technically promising. Few Members of Congress would argue for a course of action whose primary purpose is to bring business to their districts if the country's security were to be clearly weakened by such an action, but many will so argue when the threat is more dimly perceived. Nor would we insist on competition in contracting, with awards based almost solely on cost, and accept a lower quality weapon if we thought we really

needed that weapon to fight an actual war. We would not create single-function advocates with large staffs to further fragment the process and stretch out program execution time. We would not set aside a portion of our defense preparedness investment for those who are trying to break into the business. We currently attempt to maintain a warfighting posture with a peacetime, economically, politically, and socially driven approach. This may well be the price of a democracy such as ours, but it is a major cause of our apparently inefficient and sometimes ineffective efforts to provide for our common defense.

The second condition, our loss of experiential understanding of war, makes it more difficult for us to define our warfighting needs and pits the warrior against the analyst--to the warrior's disadvantage. It further causes us to lose sight of the purpose of defense acquisitions, namely, to be used in fighting war. As a result, we treat the development of the tools of war as if it were the same as buying routine items of general utility. This kind of thinking leads, for example, to proposals for a separate acquisition corps to "solve" our problems. Such proposals are fatally flawed in that they further separate the warrior from the weaponeer and further perpetuate the myth that developing weapons to provide for our defense is merely a buying problem. It is much more complex than that. It requires instead a cooperative and complementary relationship among the warriors, the political institutions, the administrative institutions, and the free market institutions--and it requires the support of the people in our society. As I mentioned earlier, this is a delicate and difficult undertaking in our democracy.

Key to making the process work is the understanding of a number of objective, verifiable realities--"truths", if you will.

The first truth is understanding the art of war and the role that weapons play in it. That truth can best be learned by experiencing war, the only--inadequate--substitute being the

practice of simulated war. The people who understand this truth must make it their profession--it is not an avocation. They must take part in the decision process about what weapons to buy and the determination of their adequacy when they are acquired.

The second truth is physical reality. What will the laws of physics allow? Can the needed weapon be developed within our current understanding of physical reality? This truth is the province of scientists and engineers, who must be partners with the weaponeers in matching what is possible to what is needed. They come from the technical schools of our universities, and support of research in such institutions, as provided by the Office of Naval Research and its counterparts in the Army and Air Force, is critical. This research must be relatively unconstrained. It may well be intended to solve military problems in the long term, but the nature of research is such that it must not be over-constrained either in its origin or its execution if it is to be sufficiently objective. The Mansfield amendment, for example, while well-intentioned in attempting to relate DoD research to defense needs, did violence to this concept by tying University research too closely to military objectives. Maintaining continued support for such technology base funding is difficult because the pressures of short-term needs almost always take precedence. This committee plays a key role in seeing that tech base funds are reasonably sufficient to the needs of the DoD.

The third truth is of the administrative and legal procedures which allows our government--which does not itself engage in manufacturing--to deal with the free market, in an efficient and legal fashion, to arrange to develop what is possible and produce what is needed. Of late, this third truth has become the whole truth to many people and is what they refer to when speaking of the "acquisition process." In reality it is a secondary and supportive truth--the procedural aspects of acquisition are useless unless they support needed weapons that can be developed within the dictates of the laws of nature. The people who make up this



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community must be a mixture of military and civilians. They must be professionals, and must be treated as such. It would be futile, however, to define them as a monolithic "corps" because they possess a variety of skills and come from diverse backgrounds. Recent pleas to the Office of Personnel Management to make acquisition a professional series, and to require people in this series to have a college degree, conflict with the laws of Civil Service which state that no requirement not absolutely necessary to perform a function will be imposed as a condition of employment. Further, the proposal begs the question of what degree should be required for an acquisition professional: a degree in the physical sciences? management? economics? It is my experience that any lack of professionalism perceived to exist in the acquisition community is due not to laws or directives from higher authority but to the relatively low value organizations have placed on this function in the past.

The fourth truth is how to design and produce the needed, feasible weapons. This truth is the business of our free market industries. It is they who must excel at effectively and efficiently translating feasible needs into form. It is these people who are often chastised because they do not produce well what we understood dimly and specified poorly. In our modern economy, where defense business is a major player, the game is serious and the stakes high. Industry often criticizes internal government institutions, such as R&D Centers and University Laboratories--who develop the people who must be the government nucleus, complementing the warriors in defining technical reality. They often argue that government labs should only carry out research and exploratory development and that everything else should be left to industry. In my opinion, such a view is short-sighted and leaves the government with technical truth-holders who have only partial understandings of the problems. This makes the government a poor customer, and in the long term industry is not well served--and the country and its defense posture are even less well served.

The fifth truth is the understanding of the political process, based on the will of the people, that empowers the cycle to begin with the approval to spend the citizen's money for defined and agreed-upon purposes. Truth in this arena is subjective, and therefore must be defined with the greatest care. It is difficult to determine what is adequate for our defense, either in magnitude or in composition. But this committee is more aware of the difficulty of this process than I, so I will not dwell upon it. Suffice it to say that the committee may not know in detail the experiential truths of either the warrior or the weaponeer, but must deal with the recommendations of both.

The final truth is in the use of the weapons in combat, which again falls to the warrior. The cycle is thus closed. The warrior who was originally involved in the definition of the need may eventually risk his life with the product of the cycle he initiated. What greater accountability than to stake your life on something you helped create?

There <u>is</u> a greater accountability, however, and that is the collective accountability of all the participants in the process--because the survival of our society depends on the competent and faithful execution of each of their respective tasks. Their collective responsibility is the first order of business under our constitution--to provide for our common defense. Deciding defense issues--beginning with what we need and ending with using the weapons--is a complex process. We must resist the temptation to solve individual problems with the process piecemeal as they crop up. We must, rather, create a system that balances in a complementary relationship the communities of truth-holders I described. We cannot have a "them" and "us" approach with the government the good guys and industry the villains. We must rethink our tendency to optimize for the short term--through, for example, the requirement for second sources of supply, which can lead in a few years to "keep alive" production at two

manufacturers. We must adequately fund the technology base, even in times of fiscal austerity.

In short, we must address the whole problem--and that may well begin with this subcommittee and the full committee recognizing and examining the related pieces of the process.

Mr. DARDEN. Gentlemen, I want to start out with a basic proposition that I want to more or less throw open to the panel. Incidentally, Dr. Carter, we realize that you have a time constraint. When you have to leave rather suddenly we will understand that you have a commitment to teach a class in the next few hours.

It came through to me, so far in our discussions, that we need to spend perhaps less money on military R&D and more money in nonmilitary R&D. You didn't say less money on the military side, but more money on the civilian side of R&D, or the nonmilitary R&D.

Now, as a general proposition, though, I think it is very evident that just because we reduce the amount of R&D in the DOD budget, it in no way means that we would increase the amount in non-DOD research and development.

I think it is evident that the vast majority of the money, spent in R&D is going to come through the Department of Defense. So the question becomes, that we are able to keep our present level, how can we better use the funds that are in the DOD budget to promote the overall national goals, whether they be strictly military or not?

I would come back to you with the proposition, then, in summary, that even if we decide that we needed more money in nondefense R&D, it is not necessarily going to be there. It will go into social security or some other Federal program.

If we cut back here, that in no way will earmark that money in the nondefense side. So my question is, assuming we can keep roughly the present level, how can we improve our industrial and technology base within the framework that we have? Do you recommend we increase the 6.1 and 6.2 functions or 6.3? How do we go about maximizing our R&D dollars here on this committee?

This is the only thing we can control. We can't control, obviously, what any other committee does. Our mission right here is somewhat finite, so what do we do—within our authority and within our mission?

Mr. LANGENBERG. Why don't you respond, Ashton, and I will follow up.

Mr. CARTER. Thank you, I will.

I couldn't agree more with the observation you made, which is that it is idle to compare the efficiency of defense R&D spending at contributing to the overall national technology base to the efficiency of spending by other agencies or by the private sector if one doesn't know how to make the transfer a dollar of defense R&D spending to one of those other categories. So I couldn't agree with you more that those comparisons would only be meaningful if we could make that transfer.

If it is not possible to make that kind of transfer, then the relevant question here is how can the defense RDT&E system be managed in such a way that it does just as good a job or a better job than it is doing now at generating defense technology for defense applications, because that is, after all, its first purpose; but still pays adequate attention to the wider national needs.

I can make two observations there that are perhaps helpful. The first one you have already named, which is that through the 1980s, we have seen the DOD RDT&E budget slant increasingly toward

the downstream development end, which is more defense-specific and less generic.

Since the amounts of money in the 6.1 and 6.2 categories are relatively small, it would seem that it would be a small change to the development end of the R&D system, to reorient some of that money toward the front end. That would help the Defense Department to do its part in contributing to the overall national technology base.

A second throught—I don't think it is at all true that when DOD pays attention to its larger responsibilities to the national technology base that that need imply that it does its own job of defense R&D less efficiently. I think there are lots of ways that we could, both with our R&D programs and with our procurement practices, make it easier for technology and the people doing technical work, be dual-use, and in particular, for companies to work to do both defense work and nondefense work at the same time.

A lot of the barriers to dual-use are not barriers of technical substance, meaning that what defense is trying to do is so different from what the commercial world is trying to do. A lot of the barriers are purely administrative ones. The way the DOD makes companies do their business is so different from the way they do their commercial business that they just feel that they can't transfer somebody from one division to another. So if DOD just pays attention to making the way it conducts business to the extent possible compatible with the way the companies are doing their commercial business, that would be an enormous help. I don't mean that we should conduct defense procurement completely as an open private-sector operation. Clearly in some cases there is only one supplier of certain defense components, particularly in the second tiers, and one can't compete everything.

I am not really talking about the difference between competition and noncompetition; I am talking about all of the practices that create a different bookkeeping and engineering climate in the private sector and in the defense sector and that is just needless. They could reinforce one another much more strongly if those artificial barriers were taken out.

With that, I do apologize for excusing myself. I have a class to teach back home in 2 hours.

Mr. DARDEN. Thank you very much, Dr. Carter.

Dr. Langenberg, would you continue along that line?

Mr. LANGENBERG. Yes. Mr. Chairman, I regret if I gave you the impression that I was advocating shifting R&D funds from military R&D to civilian R&D.

Mr. DARDEN. You didn't give me that impression. I got the impression myself that perhaps it would be better if some of this were shifted. That was perhaps an inference that I got.

Mr. LANGENBERG. I think it would be probably difficult to establish whether it would be better or not. I think—and this is a personal opinion—that the total defense RDT&E investment ought to be dictated by the defense needs of the Nation as this Government and this committee and this subcommittee contribute to perceiving them.

I also believe, however, that within that total RDT&E investment, one needs to pay particular attention to the technology base,

the 6.1 and 6.2 end of the spectrum, for several reasons. The first of those reasons I have already mentioned and that is that at that end of the spectrum, one has a higher likelihood that the funds invested and the effort invested will produce dual-use knowledge, will produce dual-use technology. A good piece of research on the new high temperature superconductors, for example, will have significant implications and potential applications in a wide variety of things, both civilian and military. In many ways, it doesn't matter whether the funding for that came out of ONR or whether it came out of NSF.

There is a second reason, too, and that is that that end of the RDT&E spectrum is the end where funds flow in largest proportions to the universities. Now, this is going to sound a little bit parochial because I am a university chancellor, but I would remark that those funds in 6.1, and in some extent, 6.2, that do flow to universities again are a dual-use investment. They produce new knowledge, new data, sometimes new technology, but they also produce new technologists. They produce new scientists and new engineers and it is at that end of the spectrum that the Defense Department contributes most strongly to the supply of a very important raw material or commodity for all of its RDT&E needs, and that is the future generation of scientists and engineers.

All of that says to me that I believe that this committee, the subcommittee and its parent committee, and all of us collectively need to look perhaps a little more favorably than we have on the relatively small, and unfortunately, not increasing proportion, of the total RDT&E investment that we make that is devoted to the technology base.

With respect to civilian investment, it is a fact of life, I believe, that the nations that we perceive as our major competitors do, in fact, invest more in what is called civilian research, a greater proportion of their Gross National Product, than we do. What the consequences of that are, I think are a little difficult to divine. If it were the fact that what was called civilian research benefited only civilian applications and developed only civilian technology, and similarly for military research, it would be easy. It is not easy because what might be called civilian research very often yields results of great benefit to military technology and vice versa.

The place where that transfer, that flow in both directions is between zero- and 100 percent is very hard to determine.

Mr. DARDEN. Dr. Colvard.

Mr. COLVARD. I would certainly fully associate myself with Dr. Langenberg's remarks. I would like to add a couple of things.

I have spent most of my career working in or managing civil service R&D centers. I would agree that the money that goes into the universities has a double salutary effect.

Also, they are the hardest to defend in the defense structure and, therefore, I would agree that you should, if possible, give them emphasis. When you are in a budget crunch, as we always are, the tendency is to solve the short-term problem, and research is a long-term proposition, research and development. So it doesn't have the glamour and the excitement, the focus of the need, the immediacy of the threat, and so it is difficult for the Defense Department to, in good conscience, support it as much as it should. So I think an

instrument of Congress that has a higher view can play a very good role there in helping to see that the right balance is struck.

I think also in my comments about out-innovating them, the maximum leverage occurs in the tech base money, both in the generation of technologists, but also in the generation of ideas. Any money that goes there has a very salutary and beneficial effect.

Mr. DARDEN. Mr. Dickinson.

Mr. DICKINSON. Thank you, Mr. Chairman.

Again, thank both of you gentlemen for your appearance here.

I have a couple of questions for Dr. Langenberg and Dr. Colvard.

What do you see as the basic difference in the approach that the United States has as compared to West Germany and/or Japan toward their research and how it is applied and adapted to military needs? Speaking of Japan, in particular, they were on the cutting edge of the computers, the supercomputers, that sort of thing, which we have adopted and used very heavily both in industry and in defense.

We have really become dependent on them for much of our technology that I assume was developed by them, whether it was subsidized by private industry or came out of a defense effort. Then the chairmen themselves have gotten heavily into R&D. They produced the Tornado, the co-development, an anti-tank shoulder-powered individual weapon and other things.

Is there a basic difference in the approach of the three countries? Do you see one as being the most effective? Are you familiar with what I am talking about?

Mr. LANGENBERG. To some extent, sir. But certainly I suspect not in the detail and to the depth that you are.

What I see or seem to see going on is largely derived from the popular media and from sources like Science Magazine, and some direct experience as a scientist—I am, like Dr. Carter, a physicist. I spent most of my life doing research on superconductivity, as it happens.

The one difference that I can see that separates the Federal Republic of Germany and Japan from the United States is reflected in the numbers that we looked at earlier. That is a certain consistency of view. There seems to be in those countries, independent of what Government or what party happens to be in power, a stable theme—the investment theme in R&D seems to be more constant there than here.

Mr. DICKINSON. What we would call IR&D, independent research and development, as opposed to military research and development?

Mr. LANGENBERG. The figures we looked at counted all R&D, whether it was civilian or military, whether public or private. There are in those nations, I think, also shifts between sectors, as there are here, but if you look at the overall national result, you simply see more stability and more consistency there.

We do have an unfortunate tendency in this country to think in terms of what the latest popular buzz word happens to be. I will give you as an example my own former field, superconductivity, which lately seems to have become very popular. I would agree that it is terribly important. The new discoveries have enormous potential, but one sees, again, a certain bandwagon effect, as one

sees very frequently here. We do not seem to have the persistency that some of our competitors have.

We are still the fount of many, I would say, even most, of the major new technological developments in the world. It is clear that, with respect to the Japanese—if you look at the fundamental scientific and early technological developmental bases of the major technologies, computers, supercomputers, biotechnology, the origins of superconductivity, the origins there are in this country.

What, however, the Japanese seem to be better at than we are is taking that technology and turning it wholesale into things that an awful lot of people around the world want or can be made to want and that they are willing to pay money for. One can express some doubt, for example, whether anybody really needs a small piece of electronics that will enable them to watch television while jogging, but nevertheless, an awful lot of people are putting a lot of money into a Japanese system that produces devices like that and are thereby funding the development of a lot of very sophisticated applied technology.

Mr. DICKINSON. Do you want to add to that, Dr. Colvard?

Mr. COLVARD. No, sir.

Mr. DICKINSON. Let me ask you, Dr. Colvard, what do you see that DOD does in this testing and development that is better than would be the standard of the practice in industry as a whole or what are we doing that is generally considered unacceptable? How would you rate military or the Department of Defense research and development to industry? What are we doing right and wrong?

Mr. COLVARD. Congressman, my knowledge of industry is pretty much limited to the military side as well. In other words, we are dealing with military equipment. It is my observation that the testing done in the military tends to be in general against more rigorous standards, higher temperatures, greater vibration, greater shock, this kind of thing, anticipating the military environment.

Now, whether or not that results in a more useful product in general is arguable. I think the weakness of military testing is in the very simple fact that you can't really test military equipment in its final configuration unless you fight a war. You can simulate certain things, but you cannot simulate the fear of death. So when you subject military equipment to hypothetical wars where people know that, unless an accident occurs, they are not going to get killed, you don't have the same level of response. There is a lot of criticism about, well, we didn't test it in the actual environment. The only actual environment is war and we don't make it a policy to go out and start wars in order to test our equipment.

Mr. DICKINSON. Yes, but we have mud, we have snow and we have water and all things that would be the same in either event.

Mr. COLVARD. Yes, sir. My observation is that in terms of the rigor of the environment, as I said, we do within the military a good job of testing it. I would argue, as I said in my very brief remarks, that you cannot test in quality. Where our emphasis needs to be is back at the integrity of the design process. You will find in systems—and the Japanese always use the example that are well done—the number of people who are involved in just purely testing is very small. Process analysis and emphasis on quality at each stage—as I said, build a little, test a little, learn a lot is the key. I

don't think there is a problem in my opinion so much with current military testing as perhaps the national philosophy of engineering.

Mr. DICKINSON. One other question that I will put to both of you. We had a witness in our first set of hearings on this same subject that alluded to the fact that we just do not draw into the Department of Defense research and development our brightest minds, our youngest scientists coming on, a new generation because we can't compete with the private industry in pay levels.

Would you see that as a factual situation or would you disagree with that?

Dr. Langenberg.

Mr. LANGENBERG. I have not had a great deal of recent experience with Defense Department laboratories, but I have had some recent experience with laboratories like the DOE-funded national laboratories, Argonne and FERMI Lab. I continue to keep fairly close track of NSF. I hear a lot from my biomedical colleagues about NIH intramural research and I would say, on the basis of what I have heard, that we, the United States, have a significant problem in the inability of federally funded and Federal institutions to attract really top-flight talent. A large part of that, I think, really does go to the question of salary levels.

I am one citizen who was out there, outside the Beltway, praying that you all were going to give yourselves a salary increase because I knew what the consequences were going to be for a lot of those people in the labs.

Mr. DARDEN. I had heard there was one.

[Laughter.]

Mr. LANGENBERG. I guess I am it.

Mr. DARDEN. We have located that person.

Mr. DICKINSON. Dr. Colvard, would you care to respond to that, too.

Mr. COLVARD. Yes, I have, as I said earlier, spent a lot of time in civil service laboratories. I believe there is a problem of attracting the best and brightest that is to a degree related to the salary situation, but I think to a much greater degree, related to the respect and utility of these people, the respect we accord them and the utility or the manner in which we use them.

Let me give you a quick anecdotic example. I used to recruit in the Midwest when I worked at China Lake, and I could get engineers to go out there in the middle of the desert, which isn't the end of the world, but it is reputed you can see it from there, to work long hours and draw relatively low pay because what they were doing was important. We were building, for example, a replication of the North Vietnamese SAM sites. We were working 7 days a week, not paying overtime, and each of these people knew they could make more money somewhere else, but what they were doing was important. They knew it. We let them know it was important.

When I say we need to keep the engineers involved, I am talking about the fact that if you treat people as managers of specifications or managers of what somebody else is doing, you can't keep quality engineers. I don't care what you pay them.

Mr. DICKINSON. I find that refreshing and I certainly agree with it. Job satisfaction, in terms of feeling a need to be contributing to

a success of something, something that is important that would come first toward both recruitment and retention.

I wonder if we don't set up a system where we sort of work against ourselves by allowing contractors, labs, whatever, under contract do work for us and pay their people more than we could pay them if they were put on the Federal payroll. They could make a lot more and we just give them money to pay somebody else because we can't pay them.

That is sort of the way we do it, isn't it, Dr. Colvard?

Mr. COLVARD. As I said earlier, you need the continuum. You have to have the industry involvement and you can't solve the problem by just paying engineers and scientists in the civil service laboratories more. I think it is helpful to get those people there. You have to have quality people. You have to really use them in engineering roles. I think the thing that bothers people within the Federal system most is the lack of apparent respect that the Federal Government has for its employees, manifest from ever-present in last memory with the notable exception recently of President Bush.

Being told that you are important and we are depending on you to do something may sound a little hokey, but it makes a difference. So, no, I don't think that we are killing ourselves by paying industry or other laboratories more. We ought to pay the civil servants a little bit more, but I see a great drift away from the role that we are having those people play.

Now, when you get those people watching the contractor do it—maturing in the engineering world is an exponential process. If you don't get a chance to develop those things, you don't understand them. You cannot teach in abstraction effective engineering. You can qualify people to understand it when they are exposed to it, but then you have to expose them to it.

Mr. DICKINSON. We are saying pride and appreciation.

Mr. COLVARD. I am saying pride, appreciation and utility.

Mr. DICKINSON. Yes.

Mr. COLVARD. People don't mind working hard; they want to be doing something that is important.

Mr. LANGENBERG. If I can just make one comment on that topic, Mr. Chairman. Some years ago, when I was active in research, I had funding at several times both from AROD, Army Research Office Durham and from ONR. I was well-acquainted at the time with the people in those offices who were the contract managers and I can tell you that, though they were themselves not active in research, they were a long way from the caricature of an unthinking, unfeeling Federal bureaucrat. They were scientists. They were respected by the people in their fields. They were people that you looked to and often looked up to.

I have no way of judging whether one has similar quality in those agencies now, but the Defense Department agencies did have them back in the 1960s and the 1970s.

Mr. DICKINSON. I want to thank you both before I sign off. I think what you said here is very important and if we could disseminate this and somehow infuse this into our total R&D thinking, it would certainly be helpful. Money isn't the total answer; you have to have job satisfaction, and it has to all go together. Thank you very much.

Mr. DARDEN. I agree with the gentleman. I don't think we have done a very good job of making our own case, or that of the other people similarly situated. I think some responsibility is probably going to be right here on us to do a much better job of making the case for better compensation in the R&D fields.

Mr. Pickett.

Mr. PICKETT. Thank you, Mr. Chairman.

What about the process by which the allocations of resources are made in the research and development area? Do you see opportunities for improvement there, specifically what this committee looks at is? What about this resource allocation process and is there anything that should be done to try to improve on it?

Mr. LANGENBERG. That, I think, is an important topic deserving of a good deal of attention. The diversity of funding sources for federally funded R&D is really quite striking. There are half a dozen major agencies that fund R&D and a number of lesser agencies that also fund R&D. It is clear that all of those agencies, among them the Defense Department, are significant players in the national R&D scene and somebody needs to be looking at the relative priorities accorded those.

For R&D, this is a natural function. It is one of the intended functions, as I understand it, of the Office of Science and Technology policy in the White House and of the president's Science Advisor. A number of institutions, including, for example, the National Academy of Sciences, have recently opined on this subject, have talked about the need for priorities to be established. Somebody has to do that and somebody has to lead that. In my view, that leadership really needs to come from the White House itself, from OSTP and the Science Advisor.

That leads me to put in a plug, if anybody is listening, that Mr. Bush, I hope, will get on with the business of finding a really top-flight person to fill that slot and soon.

Mr. PICKETT. Dr. Colvard, do you want to comment on that?

Mr. COLVARD. If you are talking about priorities between the defense research and nondefense research, I would agree that it has to be a policy level above the advocates. In the administration, that needs to be somebody such as the Science Advisor to the president, and of course, the appropriate congressional committees.

Within the Defense Department itself, it has always been an uneven process. I don't have any brilliant insights as to how you could make it smoother. I could give you some personal biases, but I don't think they are more than that.

Mr. PICKETT. Talking about the industrial and technology base, is it possible that in this country we get more out of the dollars we put into research and development than they are getting in other countries?

Mr. LANGENBERG. I would say from my own experience that that is certainly true with respect to the Soviet Union. I suspect that we are roughly comparable with most of the major European countries on the research side, of R&D judging from what I saw as I traveled about and in the old days competed with and worked with European scientists. Although our systems are different, our mechanisms are different, the general style and mode of operation of the enterprise is really quite similar.

With respect to the Japanese, I would say at least 10 years or so ago, the R in the basic research end of the spectrum was not an area in which the Japanese displayed great overall national strength. I think they have come a long way in recent years, but they were in those days really concentrating on applications in commercial developments of technology.

Mr. PICKETT. Following up on that, what, in your view, allows the Japanese to do a better job at translating the basic technology into applied applications and products, which is what you mentioned earlier?

Mr. LANGENBERG. I don't think I can really give you an authoritative view on that. I do a lot of reading of material written by people who purport to explain one or another aspect of that, but the feeling I am left with is that it is a complicated conglomeration of cultural phenomena, of Governmental organization, of personal work ethic and style, just a whole bunch of things that are different in Japan than they are here. For some reason, it simply leads or has led in the past to a remarkable relative effectiveness in bringing things quickly to commercial application and selling them very effectively.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. DARDEN. Mr. Kyl.

Mr. KYL. Thank you, Mr. Chairman. I would also like to echo my thanks for your testimony here. It has been very helpful to me and I appreciate the insights that both of you have given to us, as well as Dr. Carter.

Let me try to ask briefly three specific different kinds of questions. I would like to begin by adding my two cents' worth into a subject that was just discussed a moment ago, and that is this matter of both salary and morale of the people—particularly the people at the labs and the other people involved in basic research.

I have seen that myself and all I can do is second the motion and indicate that we have to do a better job of figuring how to get those people compensated, including supporting some kind of an executive pay increase so that they can receive this salary increase.

Perhaps the most difficult thing that these people experience at a place like Los Alamos for example, the high-level people are treated almost like assembly line employees. You never know from 1 year to the next how many of you are still going to be around and it doesn't exactly tell you that your work is important when you are living under that kind of condition. When in truth, as a nuclear physicist doing something that very few people in the world can do, there should a tremendous satisfaction in that job.

Frankly, Congress is greatly to blame and the people in places like that do correctly blame Congress. I hope we can be part of the solution, rather than the problem.

If either one of you want to comment, fine, but I think we are simply all agreeing to that proposition.

Dr. Carter had made a statement and I simply wanted to come back with something, and if not ask him, see if either of you had a comment on it. He posed the question whether R&D cuts necessarily result in increases in procurement. He said one of the arguments against it is that that is where the money goes. That isn't necessarily true. There is one area where it may be true and it is

in the area of SDI funding and I am sorry Mr. Dickinson isn't here, because one of his primary complaints is that we start with a very high SDI budget and then end up cutting it in order to make money available for everybody's pet rocks, as he calls them. Sometimes those pet rocks are procurement-type items. We are frequently taking money away from the R&D, particularly the base technology kinds of things, and then putting it into the acquisition of weapons that don't have anything to do with SDI.

I would just like to make the personal observation that it seems to me that this SDI research is exceedingly important and, second, that this is one area where, in effect, it does take money away from R&D and put it into procurement.

If either of you have a comment on that, please share it with us.

Mr. LANGENBERG. Let me just express agreement with your observation that the research in the SDI program is exceedingly important. I think it deserves continuing and strong support.

Mr. KYL. Thank you.

Let me then get into the secondary. There were two somewhat similar propositions put forth, both of which present real challenges to us. Dr. Carter indicated that one of the best ways to get the synergism between defense and nondefense technology is to have people working together. That sometimes is theoretically possible where you have a company that has both defense and nondefense and they at least have lunch together or something like that, but on this point, do you agree with that, and if so, do you have any suggestions as to how we can influence that proposition to get the people on the civilian and defense side to be working together enough that there is a greater synergism between the two? Any practical suggestions?

Mr. COLVARD. I don't know any easy way to get the defense people and the nondefense people working together, other than, as you suggested, in a company that does both products. I think there is a problem in the whole transfer process in communication these days. It is partly occasioned by our waste, fraud and abuse mentality. You are almost afraid to be seen with a contractor these days. That is regrettable because, again, they are not the enemy and we learn from each other by contact. Only through major professional societies who send you a card saying this particular get-together is sanctioned by some higher authority and is not a conflict of interest, can you even sit down and talk with each other these days.

I don't think we have looked nearly hard enough at some of the negative implications of, in my opinion, overly restrictive policies concerning association between industry and Government.

We really are lessening the communication line there.

Mr. LANGENBERG. I was going to support the observation that it really is terribly important to get people working together. I would like to associate myself with my colleague's earlier view that in matters of any technology, whether it is military or otherwise, that you really have to get the users in the process early on. That means you have to get the users working together with the people who invent, develop and build the technology. I think that is just as true in civilian technology as it is in military technology.

Now, that is a hard job because that means bringing together people, busy people with very different kinds of jobs and who gen-

erally come from very different sorts of cultures. It is a generic problem. It is, I think, not true just of trying to get people to work across the divide of civilian and military technology; it exists in institutions like mine where, if I want to get the philosophy department folks to work with the math department folks, that is a huge job. We build into our institutions all kinds of barriers. We call them organizational structures. We draw them as boxes on organization charts, but they create real barriers to social and intellectual intercourse between people and I think, you just have to keep working on it and keep trying to create opportunities where free exchange of ideas and information is possible.

I think that is absolutely crucial to the scientific research process, the engineering research process, the engineering development process. I think we must pay continuing attention to reducing or limiting those barriers where we can, consistent with constraints like national security.

Mr. KYL. That leads up to the second part of this question. How do you accomplish this same objective in involving the end user with the development of a concept and ultimately the weapon? Dr. Colvard, I think you primarily discussed this problem.

I know it works a little differently in the three services. We were talking up here a while ago about some of the weapon systems that do not appear to have been designed by the real end-user, and of course, we are talking about the guy in the field, rather than the general who makes the decisions. So it isn't necessarily enough to say, well, let the military have a larger role here; it is is who in the military.

How does that system work and do you have any specific suggestions as to how to get the real end-user involved at the most propitious times?

Mr. COLVARD. I am not advocating that you do a battlefield survey, but the Goldwater-Nichols bill did quite a bit in saying that the commanders and the chiefs out in the field get involved in the requirement-setting process. I think that is a useful first step.

The thing that I was most—addressing myself to was not so much that we don't have the military involved now; I think we do. I was really saying we should be very careful about succumbing to the idea that is we had this independent acquisition corps that went out here and took these requirements and translated them into reality, that somehow this would solve a lot of problems.

In my opinion, the military need to be involved at all steps. The degree of involvement is always an argument. One of the things that you train warriors to do is to fight war and if they have a 30-year career, you are going to have to spend a certain part of it learning war or simulated war, at least since World War II, that is mostly what it has been.

So you can't make them both acquisition experts and warriors, but somehow we have to work at bridging them. I think it is done fairly well in the Navy, in my experience, because they flow through the process. In the research and development centers, again with the Navy, where I have my experience, the military officers command the research and development centers. Sometimes that has very negative effect; sometimes it has very salutary effect. It is most positive when the military officer understands his role to

be to bring to that process the understanding of the utility of science and engineering and not to project himself as the overseer of science and engineering as a technical expert, even though they may have Ph.Ds, is some of for whom I worked did. The business of specifying from the user in the unified commands, the involvement of military officers in all the processes was really what I was driving at and suggesting we not be lured by the idea that you can do it with an independent civilian group.

Mr. KYL. I think it is a point well taken. Let me just conclude with a comment that I would like to agree with something that you said a moment ago. It is something that I think we ought to think a little bit more about as we make decisions here.

The fact that we are now doing a lot of our war planning and acquisition in a peacetime economy has given us the luxury, but there is also a downside to it of more debate and more political involvement in the process. Political in terms of members of Congress doing things for the economic benefit of their congressional districts, as much as for the national interest. That is something that, frankly, I don't look upon as a luxury at all. It seems to me that great sums could be saved and more intelligent policy could be achieved if we tried as much as possible to divorce ourselves from the economic interests of our congressional districts and focused on national policy and national interests.

The way you put it was particularly interesting to me and I will quote that in the future.

Thank you both very much.

Thank you, Mr. Chairman.

Mr. DARDEN. Thank you, Mr. Kyl.

Ms. Byron, before you begin your questions, I have a commitment I have to attend. We have a Georgian who is, I understand, to be confirmed as HHS Secretary and we are going to try to spend a little time with Dr. Sullivan today, so I have to leave. Would you please take over the hearing and when you finish, adjourn it.

Mrs. BYRON. This is what happens when you are last.

Mr. DARDEN. Gentlemen, thank you, again, and please excuse me, but as I said, Dr. Louis Sullivan is meeting with the Georgia delegation for a few moments today and we want to spend a little time honoring him. We will probably never see him once he goes over there, so we want to get one last time to talk him before he goes.

Thank you very much.

Mrs. BYRON. [Presiding.]

Let me say, first of all, that I am delighted to listen to the panel today because I think some of the things that you all have been touching on are things that I have been concerned about for quite some time.

Dr. Langenberg, let me say that, first of all, when you started to go to your charts, and I looked at that chart number 1A, I was jotting down questions to ask you and it was a total R&D, everything, and I kept thinking, why isn't he breaking out defense? We are really looking at defense from this aspect and looking at the lines.

You then moved over to chart number 8, which, to me, was the one I think you should have lead off with. Looking at chart number 8, when you have the breakdown there, when you take health, gen-

eral science and others, those are over to almost three times the amount that you find with the space defense and energy in the current timeframe.

You had stated that with the budget difficulties we are facing, your hope is not to have cuts in R&D. Looking at that chart, looking at the defense line in that chart, it has fairly been steady since the early 1980s. It has not increased dramatically at all.

Listening to your testimony, my understanding is that you would feel an increase percentage would be suitable to meet our needs. Could you define that a little bit more carefully?

Mr. LANGENBERG. Figure 8 is Federal basic research, and I assume that that, therefore, is defined as the 6.1 component on the defense line in the figure. That has increased in real terms——

Mrs. BYRON. Just in the last year.

Mr. LANGENBERG. Just in the last several years. But as percentage or as an element within the total defense RDT&E investment, it has not done terribly well in the last decade and a half. This is, I think, therefore, a bipartisan malaise.

It strikes me that although one can argue about what precisely the basic research, the 6.1 proportion of total RDT&E ought to be (that, I think, is a debate to which one can never really truly bring closure). I think there are really indications that perhaps defense has been under-investing a bit in 6.1.

It is a very small fraction of total RDT&E and increased emphasis there, I think, could bring substantial benefits certainly to defense and to its needs, but I suspect also on the civilian side. An awful lot of that research really has dual-use applications.

Mrs. BYRON. One of the things that Mr. Kyl was referring to, and something that concerns me and has concerned me over the last 10 years that I have been in Congress is that we are operating currently in a peacetime environment with our R&D where we can move slowly and methodolically and examine and go through all the widgets. Do we have the capability to develop in a wartime scenario? Do we have the depth of personnel that is necessary to go into quick emergency development?

I have looked at the personnel aspect, and I think you have to look at personnel when we are talking about any weapon system. I think you have to look at the personnel that are in the development phases, not only those in the usage.

When we talk about where we are going with our future scientists and the commitment that we have of our young people that today are in the school system that we are going to be looking to with the challenges that we see in the future, you touched on the pay scale and that issue is a strong factor. Last week, we had a hearing in this room where Dr. Hertzfeld, Dr. Morrow, Dr. Consales—we got off on an abstract in discussing immigration issues because I was talking about our national labs and the short number of advanced degree, prominent scientists that we can draw from for our national labs. One of their answers was that we need to look at the immigration laws because we are precluded, as you know, from foreign nationals operating in that arena.

Do we have a pool out there of young people coming along to develop in our R&D force?

Mr. LANGENBERG. I really believe the answer is no. Not in numbers sufficient to mount a national effort on a war footing, for example. Perhaps not in numbers even sufficient to meet our own peacetime needs in the next decade. I have been looking at some numbers recently about a problem that we in the universities are getting much more worried about, and that is that during the decade of the 1990s, we are going to have to replace significant proportions of our faculties, and particularly in science and in engineering. The numbers vary from university to university, but they tend to range from a third to a half.

If you look at the numbers of Ph.Ds that we are actually producing, you find, roughly speaking, that if we satisfy what would appear to be the projected need in industry and the Government laboratories, there are about three people left over to become faculty members.

If, on the other hand, you meet all of the faculty needs, if you simply replace the faculty we now have, you find there are about three people left over to be industrial technologists or to work in the national laboratories. There appears there to be a really significant problem, a large one.

Mrs. BYRON. I go back and look at, in the 1960s, when President Kennedy made the commitment in outer space which excited not only this nation, but it excited the young people. In the school system now, we have to find some dramatic spark, fuse, to excite those young people because, as you well know, you cannot develop a competitive scientist in the later years of their academic career. It has to be the early seeds of understanding, of questioning, of development that are going to come along to make those people want to put that extra mileage in to make that breakthrough that is going to be necessary.

Dr. Colvard, in your testimony, you stated that there are problems with qualified personnel in the R&D system, and particularly focused on engineers. That is basically what I have been talking to Dr. Langenberg about. They are not being trained properly. We have had a breakdown.

Could you get into this dialogue at the same time? What can we do to really excite the younger people to make those efforts? I don't think, frankly, the president's proposal on excellence in education and the funding is going to be the whole answer, because you have to have the inner desire of the young student, regardless of whether the funds are there or not.

Mr. COLVARD. I would agree with your point there has to be a higher appeal. I think one of the things we lose sight of oft-times in military funding is that in a representative democracy, it is difficult to get enough money to carry out the kinds of purposes we are talking about, and it may have to be focused around something like—the one you mentioned was not military, the NASA, or the man on the moon, but SDI is, I think, an equally valid point. So there has to be kind of a call to a greater purpose.

What I was talking about in terms of the development of engineers is the tendency over years with organizations to shift emphasis to the administrative process and away from the engineering side so that when you do get engineers in, they are bright engineers, and I would agree with Dr. Langenberg, that, yes, the Gov-

ernment does have good engineers. I have managed large numbers of them for many years, but it became more and more difficult as time went on to keep those people involved in hands-on endeavors that kept them currently technologically capable so that they could be the interface, they could deal their industrial counterparts or the university counterparts as knowledgeable people.

The roles that we allow organizations to play, for example, in carrying research and development to the point of demonstrating a proof of principle or a prototype, we often cut back in that. We tend to say, why don't we turn it over to industry sooner and lose sight of the fact that, first of all, we haven't gotten to the point of really proving that it will work. We have simply proven that the laws of physics don't forbid it.

So if you stay in that cycle very long, you get too many engineers who become now quasi-administrators and they lose their technological currency. I think that is something that causes people to leave the field.

I mentioned about recruiting in China Lake. I thought one of our drawing cards was the fact that we gave these engineers important things to do very early. We put them right in the middle of it. We didn't send them off to a corner and say, study up and watch the big boys do it. We dropped them into key projects in responsible positions.

I went in there as a young engineer or a physicist right out of college and was designing a cool cell alternate for Sidewinder, a real weapon, doing real things.

Mrs. BYRON. I don't mean to be disrespectful, but that was not today, and what has happened with us and with our revolving funding levels. Those young engineers who are coming into a China Lake scenario are given an enormous amount of responsibility early on. But after they have been there 4 or 5 years and have had to fight the budget cycle and fight the cyclical nature of their program, they then tend to think, "hey, there is a better way to do this."

You mentioned SDI in comparing that with going to the moon. Those young people in our school system that looked at SDI several years ago as an exciting new challenge—by the time we look at it today, it is so badly beaten and battered, they have long forgotten that as an exciting program to want to be part of down the road, from my estimation.

Mr. COLVARD. That is a reflection of the thing we mentioned early about the process is clearly very political. But I would like to respond a little bit to your first question; that is, can we today mobilize in the face of an emergency?

I think the answer is both yes and no and it is not an equivocating answer. It is yes in the following sense. We would suspend an awful lot of the rules we have today and we would find, as the British found when they went into the Falklands. For example, they had plans to put carrier decks on merchant ships and these involve, like, 2 years. Those may not be exact numbers, but long periods of time.

When they had to go and do them for real, they did them in 6 weeks, because you didn't compete; you didn't worry about set-asides; you didn't worry about all the things that you do when you

are at peace, and so, yes, we could surge. If we said, we are not going to worry about profits; we are not going to worry about this; we will look at that after the fact to make sure people didn't rip off the Government.

On the other hand, we have driven the industrial base to the point of not being prepared for surge through a very major emphasis on competition. I am not against competition. I think competition makes a lot of sense when appropriately used, but when it becomes the totality of your business, in order to be efficient, you have no reserve capacity because reserve capacity is overhead.

So, no, we are not ready with a reservoir of people or a reservoir of facilities to surge. On the other hand, there is a latent capacity there. In the short term, we could surge.

Mrs. BYRON. On the same subject of funding levels—we have been informed that DOD now not only looks at obligation, but also the expenditure of the R&D funds by the end of a 2-year appropriation period.

Dr. Colvard, could you explain the situation, if you can, and its impact on the R&D? Previously, you could have had the appropriation, but the funds were not necessarily completely spent in that 2-year timeframe. Has that been a detrimental policy?

Mr. COLVARD. Yes, it has. Let me explain briefly what that refers to, or at least as we experience it. I don't know about all of DOD, but the Navy has started interpreting very recently that moneys that are obligated to an institution that is operating on a level-of-effort contract, which most research and development is done under, must, in fact, have expended the research and development funds at the end of the 2-year appropriation cycle, rather than, as previously done, that once they are committed, you can complete the work because the work is, indeed—in spite of the fact it is called level of effort, it is a defined, specified piece of work toward an intended objective. It is not a bodyshop operation of you give me $x$ number of people for $x$ number of years.

What this does is puts an added burden on the accounting at both ends. The program manager, who is sending money to an institution, and the people who, in fact, are expending the money because now they have to account for it by the year of appropriation, et cetera.

What this is is another aggravation in the administrative process that, in my opinion, is not necessary. So it takes people power from the business of going out again and doing science and engineering and focuses it within an institution on the administrative process, when there is, in my opinion, no value added.

Mr. LANGENBERG. I would comment that this might put just a little bit of bias into the system against the R end of the RDT&E spectrum because research activities, I think on the whole, are generally faster outlay than test and evaluation and acquisition of long lead time weapon systems, for example.

So researchers spend fast; acquisition spends a lot more, but a lot slower and there may be a tendency to put a little bit of bias in the system against the investment in the research.

Mrs. BYRON. Having attended two hearings, I think if I were a young person, I would get my CPA degree because that seems to be the buzz job that is going to be available.

Mr. COLVARD. You could do as some physicists and get a law degree.

Mrs. BYRON. I have no further questions. Either of the professional staff members have any questions?

I want to thank both of these witnesses and the subcommittee will now stand adjourned until 2, when we will hear from the Defense Advanced Research Projects Agency Director, Dr. Colladay.

[Whereupon, at 12:15 p.m., the subcommittee was recessed to reconvene at 2 p.m., this same day.]

## DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

### AFTERNOON SESSION

### STATEMENT OF HON. DAVE MCCURDY, A REPRESENTATIVE FROM OKLAHOMA

Mr. MCCURDY. The Subcommittee on Research and Development will come to order.

This afternoon the subcommittee will take testimony from the first administration witness on the fiscal year 1990–1991 Defense budget.

The chairman of the subcommittee, Mr. Dellums, unfortunately, is ill and is not going to be here this afternoon. He asked that I fill in for him.

Mr. MCCURDY. I think it is extremely timely that we have Dr. Ray Colladay, Director of DARPA, as our first administration witness, given the testimony that we have received in the last two hearings concerning long-range R&D strategy, plans, and support for technology, and our industrial base.

Dr. Colladay, I would personally like to compliment you on your prepared testimony. It was very readable, and I believe outlines a logical basis for reviewing your budget. Also having a long association with Dr. Colladay from both NASA, when he was over there, and the other subcommittee that I chaired on Transportation, Aviation, and Materials; and also Craig Fields who is with you as well, and Bob Moore, we appreciate your involvement in the work that you do.

I am particularly glad to see that in your statement you have provided an investment strategy that allows us to make some logical assessment of program plans and accomplishments. The subcommittee appreciates, as always, the time that you take with those.

Before we begin, Mr. Dickinson, I understand is on his way. If there are no other statements from members, Dr. Colladay, your testimony, as always, is admitted in its entirety into the record, and you may proceed in whatever fashion you wish.

PREPARED STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

The R&D Subcommittee held its first two hearings on the subject of long range R&D planning. Therefore, it is appropriate that our first administration witness be the Director of the Defense Advanced Research Projects Agency (DARPA).

Dr. Colladay, it is good to once again have you as our witness before the subcommittee. We all look forward to working with you this year on the DARPA budget.

The relationship between Congress and DARPA is important. In fact, we are aware that your fiscal year 1990 budget request is less than this year's DARPA appropriation. I hope that past practice continues and that congress increases your budget. I hope you will share your views with us on such increases as well as on the impact that a declining budget would have on DARPA.

While I know DARPA has more interesting programs than we could possibly discuss in only one hearing, I would appreciate it if you could discuss your armor antiarmor and light-sat programs. These programs are particularly important in light of Soviet conventional force capabilities as well as their operational ASAT system. I look forward to your testimony.

Thank you, Mr. Chairman.

**STATEMENT OF DR. RAYMOND S. COLLADAY, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY, ACCOMPANIED BY ROBERT A. MOORE, DEPUTY DIRECTOR FOR SYSTEMS AND TECHNOLOGY, AND DR. CRAIG FIELDS, DEPUTY DIRECTOR FOR RESEARCH, DARPA**

Dr. COLLADAY. Thank you, Mr. Chairman, and members of the subcommittee.

I will take the opportunity to summarize that rather lengthy statement and hit some high points of what I would like to convey as an overall framework to consider our biannual budget request for 1990 and 1991. In my statement I try to summarize the sense of DARPA and where we're headed, and as you observed, the investment strategy, in order to help to understand where we are headed over the next 10 to 20 years in R&D.

I also try and lay out broad Agency objectives in how we operate within the Defense Department. I think that's very important to understand that for DARPA, with one-third of 1 percent of the Defense budget, and an understanding of the needs of defense.

DARPA is a place where you are encouraged to look for the imaginative solutions in advanced technology, unconstrained by traditional thinking and approaches; not being wedded to any one service point of view, and not captive to any institutional commitment. We are perhaps in a unique position in the Department to look across the needs of the services and look at multi-service solutions to and approaches to advanced technology.

That independence, however, does not mean isolation. We have technical program managers, many of whom are military officers, who understand the needs of defense and can address advanced technology to meet those needs.

The independence also brings with it an important requirement that we all feel to work with our customers to ensure that the technology that we develop transitions to the services. If we develop technology that ends up on the shelf, there's no real reason for DARPA to exist. I think every DARPA director for the last 30 years has made it an important priority to concentrate on working with our customers, maintaining independence, and ensuring that the technology developed is transitioned—that's working with the services , with the Joint Chiefs, with the unified and specified commands and, of course, with industry. A lot of the basic technology that we develop transitions in a rather circuitous route from DARPA through the industry and back to the Department.

The environment that we face today is also an important part of the backdrop of our investment strategy and that changing envi-

ronment is dominated by the reality of constrained defense budgets.

But while we see that constrained budget, there's no less demand for advanced technology. In fact, we're in a period today where advanced technology is addressing some of the crucial needs of defense, and it is through technology that DARPA is developing; that we see the answers to advanced weapon systems that are affordable and highly reliable, and can give us the force multiplier effects that we are going to need in the future.

Arms control also places demands on advanced technology, in both verification technology as well as through the INF and START negotiations—we have more emphasis placed on conventional weapons or improvement of conventional weapons. Terrorism and special operations, low-intensity conflicts also put new demands on advanced technology. The growing trend or concern about critical technology moving off-shore is also part of that environment that's influencing our investment strategy.

Now, there's been great acclaim over the years, and certainly most recently, about DARPA'S impact on commercial ventures. I should point out that DARPA's mission is and always has been focused on defense. But we recognize the technology spin-off value of much of the work that we do, particularly basic research; and also through our support to universities, where we are really training the scientists and engineers of tomorrow in crucial fields like computer science and many other engineering disciplines. So DARPA has a value that goes beyond its mission of defense—we recognize that, but our focus is on that mission.

The investment strategy, as I have laid out in my written statement, is focused on five principal themes, or legs of that strategy. I would like to briefly walk through each of those.

The first is to move aggressively in those technologies that have the broadest field of application and, therefore, the highest leverage in enabling advances in future weapon systems. Virtually every system benefits from advances in information processing and advanced materials. Our investment is guided by the belief that advances in these two fields paces system development.

Now, information processing covers a wide field in itself, and by that I mean our traditional DARPA emphasis in high-speed computing, in high-speed computing networks, and artificial intelligence.

We have been pushing the boundaries of high-speed computing for many years, and most recently through the Strategic Computing program in the area of parallel processing, we have essentially departed from the historical trend lines in going to advanced architectures using advances in algorithms concurrent with that to push performance up to levels of 10 to 50 billion operations per second, with a goal in the next year or two of achieving 100 billion operations per second.

We are doing that with fairly conservative hardware—nothing really very advanced in the way of microelectronics yet. We have been bringing those fields along to now marry with the parallel processing architecture to achieve what is the next real goal in our Strategic Computing program, and that is a trillion operations per

second, or through the TeraOp program that I referred to in my statement.

We think we can achieve that because of the approach we've taken in bringing along massive parallelism; added to that will be optical interconnects, digital gallium arsenide VLSI chips, and high-density 3-D packaging. Those are many of the same technologies that, incidentally, are required to build faster computers in smaller volumes using less and less power, which is really the nub of our Strategic Computing applications into smart weapons and unmanned platforms, and on-board processing, that is placing such a large demand on computer technology.

High-speed networks is also important, that is, to distributed computing what parallel processing is to an individual computer. There our effort, in coordination with NSF and NASA and other Government agencies, is to push for extremely high data rates on the order of Gigibits per second that will allow truly distributed computing parallel processing across large local area networks and even across the country by way of satellites.

Artificial intelligence is the other component of Strategic Computing and, as well, DARPA has been investing in that for many years. We see technology coming out of the laboratory is being applied in many applications that we have been pursuing with the unified and specified commands as well as the services.

One part, of what I call a subset of artificial intelligence, that really brings in the massive parallelism that has been part of our Strategic Computing program is neural networks. There have been a number of advances made in neural nets in the past few years, and DARPA is going to proceed serving as a catalyst to try and bring this activity along and see how we can push it for militarily useful applications.

There are four benchmark experiments and simulations that we're considering in this new neural network initiative. One is automatic target recognition, and there's been some work already at Lincoln Lab and other places in small advances in neural nets.

Sonar analysis is another of the benchmark applications that we're considering as are speech recognition and finally, detection of nuclear tests in seismic signals.

That rounds out roughly what we're doing in one of these twin building block technologies.

The other, as I mentioned, is advanced materials. As part of our advanced materials program we're, as you know, beginning the third year of our high-temperature superconductivity program. It's off to a good start, with the help of this committee, and you personally, Mr. Chairman, being able to move out quickly in this important field to gain a U.S. advantage.

We have some 35 contracts under way now out of over 200 proposals that we received. We're also looking at some possibilities for consortia that can get more leverage by teaming among industry and universities.

But DARPA's investment is complementing what others in the services, and particularly NSF, is doing in the basic materials research by focusing on materials processing, and bulk thin film and wire configurations, and to not wait until we have the materials to begin to look at device technology. We have focused a part of our

resources on moving ahead and considering various devices like analog-to-digital converters and IR detectors and the like to be ready when the materials and the processing matures to be able to quickly field advanced devices using high-temperature superconductors.

The second of the legs, if you will, of our investment strategy, having just touched on the basic technology, is in lowering the cost of defense, focusing on technology to reduce cost of defense. It doesn't do any good to develop the latest and best technology if it's unaffordable when it's transitioned into fielded weapon systems. There, probably the centerpiece of the thrust in reducing the cost is in manufacturing technology. We have taken on a new mission in DARPA of sizable proportion, given its relationship to the other DARPA efforts, in manufacturing initially focused on semiconductor manufacturing.

A number of programs that were under the responsibility of the Director, Defense Research and Engineering moved to DARPA in this past year, including Sematech and the MIMIC program and IR focal plane arrays. This serves as a nucleus for a very concentrated effort in semiconductor manufacturing that we think is extremely important if we're going to maintain for the United States, a domestic source for important electronics equipment for defense as well as its spin-off value to the commercial sector, and to make sure that we have affordable components for the future.

We haven't neglected software either; we recognize that that's an important part of military systems and we usually end up running into major problems in software, and we think that that lends itself to technical solutions which we are now laying the groundwork for.

Simulation and training is another area that DARPA is involved in a major way to reduce costs. Our SIMNET program is transitioning to the Army, and it's a huge success. I think it is going to change the way we consider and approach training. It has implications as an acquisition tool to look at advanced systems well in advance of bending metal and building hardware.

Distributed Wargaming is another simulation and training effort that DARPA is involved in, and I think you will learn more about that when the Army speaks; and it's good to let a customer address some of the technology that we develop. It always means more when they comment on it than when DARPA does, so I will leave that to them. But it is important as a prototype that we're developing for SACEUR and General Galvin to support a major eighth corps training exercise in Central Europe for November of this year.

There are other approaches that we take in addressing cost reduction like multi-mission platforms and joint service efforts that DARPA is particularly keying on addressing because of our view that cuts across all the services.

The third leg of our investment strategy addresses the part of the program that I characterize as technology pull. Much of DARPA's investment is geared to responding to opportunities that come along, and we take pride in moving quickly to try and do that.

I have outlined six areas that represent what we consider to be major threats that can be impacted by advanced technology.

The first of those is ASW, and that's probably the most, without question, severe threat to our tactical and strategic forces. DARPA is addressing the technology that can come to bear on ASW, in both the Advanced Submarine Technology Program that is currently under way, as well as the ASW initiative report that we submitted in response to a request of Congress just last week.

The ongoing program in ASW addresses non-acoustic and acoustic sensing, advanced processing, unmanned underwater vehicle program, advanced torpedo technology, as well as the submarine technology that I mentioned, and submarine laser communications.

I understand there is going to be a special joint subcommittee hearing next month on ASW and submarine technology, so I won't address those programs in any detail. But let me just point out that the Advanced Submarine Technology Program is still proceeding on its original implementation plan, although, as you know, the decision was made not to include it in the budget request for fiscal year 1990 on the basis of overall affordability.

The program, which is focused on hull, machinery, and electrical applications, is improving the technology base for advanced submarines over the long haul in areas of submarine stealth, survivability, and payload fraction, while addressing the ever important issue of cost.

The second major threat-driven technology is in air countermeasures, and that is principally focused on the evolving threat that we see emerging in advanced technology systems for the future; as well as our hypersonic weapon technology that is a multi-mission, multi-service platform for long-range intercept in applications of ADI, the outer air battle defense of carrier battle groups and defense of our strategic armors.

Brings all of the pieces together of former DARPA programs and hypersonics, and high altitude long endurance platforms for queuing, conformal radar rays in earlier predecessor programs using the SWERVE vehicle at Sandia; all addressing what we think will be a practical multi-mission weapons system.

The third area of this threat-driven technology programs is in Armor/Anti-Armor. We've had, as you know, a joint program with the Army and the Marine Corps. It's now in its third year, and going well. In fact, I think we're just now beginning to see some of the real fruits of that investment that range across a number of different specific technologies as well as a way of doing business.

We've created a technology base that's been brought out into the private sector industry that didn't exist before with a number of contracts, some 100 contractors and 25 primes, and 2 national laboratories.

We have a red design bureau that's part of that program that is better able to make projections of the threat in the future. We have kinetic energy and chemical energy warheads that have shown real promise against future projected threats; and low-cost armor, ceramic armor, and improved survivability. So the program is going well, and some of the technology is beginning to transition to the Army now and we see it continuing in the future.

The fourth area is Strategic Relocatable Targets. That's just a tough problem. There's a lot of work that needs to be done, and sensors, and algorithms for processing. There are no quick answers there, but we think we are developing a database that is going to chart the course for where the technology should go in the future.

The fifth area is in assured space assets, and satellites, that really is the basis for our lightweight satellite program, which we call the Advanced Space Technology Program. It used to be known as Lightsat. That is proceeding according to the original plan with the resources that the Congress added in fiscal year 1988 and fiscal year 1989. We have limited ability in the 1990–1991 budget to proceed with the advanced technology that we think is so promising, but we are making headway.

We have a Broad Agency Announcement that's out with very good response from industry and universities that are addressing advanced technology for future systems that I think is going to really make the case for what we've been saying about Lightsat and its importance over the past several years.

The sixth and last area in these threat-driven technologies are technology for Special Operations and Low-Intensity Conflicts. We don't have a large program there but it is well suited for the needs of the Special Operations Command with our electronics program and small sensors, and unattended ground sensor networks, high-power density batteries, and the like.

I have been working with General Lindsey in SOCOM to formalize a relationship between the two organizations, because I think DARPA and the Special Operations Command are kind of kindred spirits in terms of what we are trying to do in technology, and the fact that sometimes they need small quantities of advanced systems that could take prototypes that we would develop and actually use them in an operational sense.

The next area in the five legs of this investment strategy that I point out in the written statement is in technology to exploit competitive advantage against weaknesses of our adversaries. DARPA has long championed many of the technologies that are addressed in the competitive strategies theme. So while that is new in form, it's not new in substance to DARPA, and we intend to continue to push areas like automation, and sensors, and microelectronics, and unmanned platforms that play to the competitive strategies thrust.

Many of those happen to be in high leverage force multiplier areas that have long been a DARPA strong point. We've had a program, and still do, in unmanned air vehicles, which developed AMBER. The AMBER vehicle has been transitioned to the Navy, now swept up under the UAV Joint Program Office. We have the high altitude long endurance platform that we're looking at that Boeing has tested, which, by the way just completed I think the fourth in a series of flight tests yesterday; reaching designed altitude and planned endurance in a 12 hour test.

The Unmanned Underwater Vehicle is another example of unmanned platforms.

The Pilot's Associate is probably the most stringent application of artificial intelligence that we're pursuing. I am happy to say that that is our third approved prototype program that starts in

fiscal year 1990 to bring that technology along to show its application and practical operating performance for fighter aircraft.

Smart Weapons with sensors around automatic target recognition is an important part of this thrust, as is reconnaissance, surveillance and target acquisition platforms that we are considering.

Smart Mines fall in to that category, where we've built up an effort following the Defense Science Board recommendation some 2 years ago, that we had overlooked the application of mines, particularly when they can be operated in a network—it makes them controllable and with various degrees of smartness.

Our Enhanced Fighter Maneuverability program—X–31—the first international X airplane program is going well, on schedule, on cost. The roll-out of the first airplane is due in the October–November timeframe with flight tests in fiscal year 1990. The program, I think in addition to its own merits in post-stall maneuverability is going to tell us a lot about vehicles in the ASTOVL area—Advanced Supersonic short takeoff and vertical landing—which is another effort in Nunn-initiative programs.

The last area of the five strategies is Technology for Treaty Verification. We have been working for almost the life of DARPA in developing technology for treaty verification and a nuclear test ban. In this past year, with the help of additional resources that Congress added to the budget, we have been able to bring on two new high-frequency phase arrays in finishing the one in Norway and a new one in Germany, that give us a yield estimation ability that is on target with our goal of being able to estimate accurately within plus or minus 30 percent the one kiloton nuclear underground explosion.

Let me, in conclusion, address briefly the budget request. In fiscal year 1990, we are requesting $1.12 billion, and that goes to $1.164 billion in fiscal year 1991.

I would like to make a few observations—three, as a matter of fact—about that budget. First is the 6.1 basic research area. We have held it at the 10 percent level in both 1990 and 1991. That's up a little from fiscal year 1989; it's up a little further from fiscal year 1988. I consider the 10 percent level to be a minimum and will not let it go any lower than that if we take further budget reductions, which I expect we will have to in meeting the new target level of President Bush. We will not take those reductions out of the 6.1 basic research area.

I think that's terribly important to DARPA's future as it is to the Department of Defense as a whole.

The second point that I would make about the 1990 budget, it looks like it's up considerably from the request of fiscal year 1989, but it includes the expanded effort and our expanded mission in manufacturing programs—some $250 million that was added to DARPA's budget along with some of the resources in manpower to take on this new responsibility.

The third point that I would make, as you will see in this budget, a new budget category in 6.3A for prototyping. I did that for two reasons: One, to provide visibility for this important area. Second, I always hate to cut my own flexibility, but in this case I wanted to erect a little of an accounting barrier between these major prototype programs and the rest of the DARPA's budget, just for the

fiscal discipline that that provides. They are big programs and they can run into cost difficulties and we wanted to make sure that they didn't bleed into the rest of the budget.

In conclusion, I would say that I think DARPA's role to the Department of Defense is extremely important. Our independence is important and we cherish that. We actually take pride in bucking the status quo and I think that's important that there is a part of the Defense Department that can look across the needs of defense in the area of advanced technology and not be constrained to any institutional commitments or a particular service views.

In fact, I think if we didn't have a DARPA today, we would have to create it. It has been a good year, overall, for DARPA. We have had a lot of accomplishments that I've mentioned in the statement.

But I would also have to raise the same note of caution, except underscored, that I did last year, and that is, I think we are stretched extremely thin. We have recruiting and retention difficulties that I mentioned last year, and nothing has changed to improve that situation.

We are a small Agency. We try and move quickly to respond to technology opportunities. With the growth that we've had in the changing mission of DARPA, that's put us under some strain. We are dealing with it, I think, very well. But sometimes we are not able to respond in the traditional way that we take pride in doing, and that's because we're struggling with the commitments and the level of manpower we have. The manpower level is okay. It's the difficulty in recruiting.

We need to attract the best people in the country—scientists and engineers, entrepreneurs, and good managers. That's all DARPA is. We don't have laboratories or any other institutional elements to the Agency, and we rest on our people. We've got to be able to attract high quality talent. We have it now, but I worry about the future.

With that, Mr. Chairman and members of the subcommittee, I would like to open it up and answer any questions you might have.

## Prepared Statement of Dr. Raymond S. Colladay

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to appear before you today to describe DARPA's research and development program for the biennial FY1990/FY1991 budget request. I want to address our broad agency objectives, how our environment is shaping the way we approach those objectives, and what our investment strategy is for meeting those objectives.

### Broad Agency Objectives in a Changing Environment

#### Agency Objectives

As its name implies, the Defense Advanced Research Projects Agency functions as the central research and development arm of the Department of Defense or, if you will, the "corporate" research organization of the Office of the Secretary of Defense, to use a private sector analogy. Our charter is to pursue high-risk technology that promises high payoff in military utility. By being willing to take risk in pursuing advanced concepts having revolutionary potential, we are able to exploit technology to gain a decisive advantage against our potential adversaries. Our technical program managers have a keen understanding of military needs and can formulate advanced concepts to meet those needs, often with an unconventional approach. In DARPA, you will not find the "school book" solution to our national defense problems. I consider that to be one of the principal advantages of having an independent organization like DARPA able to look for multiservice, sometimes revolutionary solutions -- in fact if the organization did not exist today, I think we would have to create it.

In the rapidly changing national defense environment we find ourselves in today, technological superiority will be even more important than in the past. But "high technology" alone will not be sufficient to meet the national security

challenges of the next decade. Technology advances must translate into cost-effective fielded systems with enhanced capabilities and greater flexibility and reliability than ever before. We are placing increased emphasis on cost reduction technology, particularly in microelectronics manufacturing, and on multi-mission platforms to meet joint-service needs. Ultimately, our technology products must be transferred to the military services, either directly for major systems or by way of industry, which is the route most of the basic, broadly applicable technology usually takes.

Without transition of its technologies and programs, there is no reason for DARPA to exist. And because of its importance, every DARPA director for the past thirty years has recognized the emphasis that must be placed on transitioning technology. Technology transition is aided by contracting through the services, which is still the principal way DARPA operates; by managing its programs with Service participation through military officers in DARPA; and by demonstrating technology in the form of prototyping systems or subsystems.

While there has been great acclaim about DARPA's impact on commercial ventures, our mission and focus is on defense. But in its role as promoter of new technology for defense, we realize DARPA's value to the United States goes beyond defense. For example, through its sponsorship of university research, DARPA supports the education of nearly half the U.S. graduate students in computer science and a large fraction of those in other key technical disciplines. Thus DARPA contributes significantly to the development of our most important resource for the future, the leaders of a workforce proficient in science and engineering. Also, technology developed by DARPA for military purposes not only strengthens defense, but often brings new technological products to the commercial market, strengthening the U.S. economy. This is particularly true of our more basic technology, like high-speed computers, electronics, and advanced materials. Since a nation's defense is ultimately tied to the productivity of its workforce and the vitality of its economy, DARPA's investment in universities and new initiatives provides a return far beyond that which is directly measurable in terms of military value.

ENVIRONMENT

The environment we face today is dominated by the reality of severely constrained defense budgets. But while budgets are reduced, the importance of advanced technology does not diminish as new demands are placed on national defense in a changing world. Our evolving and dynamic relations with the Soviet Union require that we emphasize those technologies where we have a competi-

tive advantage to exploit their weaknesses. Much of DARPA's program -- in sensors, embedded computers, smart weapons, automation, and unmanned vehicles -- lines up with this "competitive strategy". Other threats from the Soviets are also influencing our technology programs. For example, the Soviets are continuing to field land mobile strategic systems that pose very difficult technical challenges to our ability to locate and hold these targets at risk. Also, they have begun to deploy their strategic submarines in areas where our ASW and undersea surveillance capabilities are limited. The North American continent is threatened by their strategic bombers as well as sea launched cruise missiles and they continue to hold a dominating advantage in the armor and antiarmor balance compared to the U.S. and its NATO Allies.

Developing technology strategy and plans can be complicated by arms control agreements. We must understand potential force instabilities that can be created and the constraints that might be placed on some of our greatest technology "levers" and advantages. It is also important to recognize the influence that technology advances can have when appropriately demonstrated. The INF treaty and START negotiations pose new challenges to our technology for treaty verification, and a reduction in nuclear forces places increased demands on our technology aimed at improvement and modernization of conventional forces.

Outside the strategic realm and the NATO defense arena, terrorism will continue to be a serious threat and regional conflicts will potentially be a greater danger due to the proliferation of advanced weapons technology throughout the world. This threat demands that we fully exploit our technology for crisis management and control, surgical strike, low-intensity conflict, and special operations. We are working closely with the Special Operations Command to insure that our technology addresses their unique needs.

Our technological response to this changing military environment is further colored by the Nation's commercial and consumer economy, and particularly the movement off shore of critical technologies, like semiconductors. That globalization of technology, at best, may give our military adversaries equal access to the latest technology and, at worst, may give them access to superior technology or earlier access to technology than that available to U.S. defense companies for building military systems.

In planning the DARPA program, we try to develop a technology strategy for the future which is sensitive to this dynamic environment. It is important that we understand how this environment might evolve and what technologies and

advanced system concepts will have the greatest payoff. On the other hand, no investment strategy is rigid, especially in DARPA. We are always prepared to exploit opportunities that result from breakthroughs in our programs that come serendipitously.

## DARPA R&D Investment Strategy

DARPA's response to these challenges and opportunities is an investment strategy which I will describe and use as a framework to tell you of our plans for the program in our budget request and to highlight some of our major accomplishments of the past year. The strategy is built around five primary thrusts. The first is to assure that we move aggressively in those technologies that have the broadest field of application, and therefore the highest leverage, in enabling advances in future weapons systems. Second is to focus on technology to reduce cost of defense. Third is to respond to major, known threats where technology can have a dramatic impact. Fourth is to exploit those particular technologies that will give us a decisive competitive advantage against the weaknesses of our adversaries. And fifth, is technology for treaty verification.

### Leadership in High-Leverage Technology

Virtually every system benefits from advances in information processing and advanced materials. Our investment is guided by the belief that advances in these fields paces system development.

For nearly thirty years, DARPA's investment in information processing has provided Defense with the most advanced computing technology in the world. One current focus in our fifth generation Strategic Computing program is to push out the boundaries of parallel processing supercomputers to achieve the highest possible performance. This will make practical military applications that are simply not feasible with current technology.

In the last few years several hundred of the first wave of these new machines have been deployed, including the experimental use of one product, the Aspen computer built by AT&T, in a submarine acoustic detection application. In the next few years, we will have pushed performance to 100 billion operations per second for certain data processing applications. These remarkable advances have been accomplished through innovations in computer architecture and software, but the hardware itself has been implemented with relatively conservative microelectronics. We are now going to take the next logical step



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by incorporating other technology which DARPA has been pursuing in its electronics science program; namely optical interconnects between processors, digital GaAs VLSI circuits, and high-density 3-D chip packaging.

By combining advanced computer designs and the leading edge electronics being developed by our contractors, we expect to achieve performance levels of a trillion operations per second by the mid-1990s in our TeraOp program. This kind of capability will enable such applications as real-time ASW signal processing, complex fluid dynamics with turbulent and separated flow, and automated imagery analysis.

Speed is not the only performance advance we are seeking. In high density packaging, last year we were able to produce a 25 Mhz signal processor and a 9 Mbit memory in volumes 100 times less than current practice, and we expect to have a billion operation per second supercomputer packaged in 10 cubic inches next year. This work in packaging is critical if we expect to embed supercomputers in smart weapons sufficient to provide the "smarts" for the sensor fusion and data processing required for automatic target recognition. Such small embedded supercomputers are also essential for tomorrow's generation of unmanned air and underwater vehicles, for smart networks of unattended ground sensors and mines, and for many space applications where onboard processing will be mandatory if we are to avoid being flooded with a glut of data.

We are "going optical" in connecting our computer components -- in one case replacing 25,000 wires with 24 optical fibers. That has a tremendous effect on cost, power consumption, reliability, volume, and radiation hardness.

For several years we have been refining the production of digital gallium arsenide circuits. You will recall that gallium arsenide uses about 25 times less electrical power than more common circuits made from silicon, and is also 5 times faster. This makes possible even smaller and faster supercomputers. Unfortunately, our skill in manufacturing these gallium arsenide circuits lags behind silicon. Last year we achieved 10 percent yield levels with the 16K SRAM gallium arsenide and equivalent complexity chips, making it viable to include this technology in military systems. We are looking at opportunities to insert gallium arsenide into fielded military systems to upgrade performance when platforms outlast several generations of electronics technology. This is an attractive approach to upgrade performance when budgets will not allow replacement of the entire system. We have found applications in signal processing and

computing, in electronic warfare and intelligence, and communications for space based, airborne, land based, and shipborne systems.

Looking farther into the future, you may have read about the development of transistors that use quantum tunneling, and which promise 1000-time reductions in the size and power of electronic devices. We supported that work with industry to lay the groundwork for even higher performance by early in the next century.

In developing this advanced hardware, we have not neglected software. We developed the Mach operating system specifically for these kinds of machines as a successor to UNIX. Mach is now available for 9 kinds of machines and is deployed at over 150 sites. Incidentally, this is one of the few software projects that was designed, from day one, to be certifiable for classified work.

Before leaving the area of high performance computing, I want to mention our new initiative in neural networks. Many researchers have been building small neural nets that show amazing performance in learning to make discriminations and classify patterns. We are going to see just how far we can push these concepts by evaluating neural nets at a scale never before attempted. We are evaluating neural nets for automatic target recognition, sonar analysis, detection of nuclear tests in seismic signals, and speech recognition.

In addition to high performance computing, computer communication and networking is essential to the military, and DARPA is committed to developing the technology for billion bit per second (Gigabit) military networks. These will make practical the transmission of imagery of all sorts, as well as increasing military network survivability by making it possible to organize and locate our data in new ways. The first demonstrations of this technology will occur over the next two years.

DARPA has a major effort in artificial intelligence, a field that is bearing fruit after years of DARPA investment. Last year at Carnegie Mellon University, we demonstrated a system called Sphinx which sets a new world standard for performance -- a thousand-word continuous speech recognition system with 96 percent accuracy without prior training of the system to learn how to recognize the speech of a particular speaker. We demonstrated that automatic image understanding can be successfully applied to important problems in image analysis. In a joint program with the Army, we used artificial intelligence to reduce the time necessary for planning a complex military activity from the customary

24-48 hours to 2 hours, a significant tactical advantage. And in work pursued jointly with the Air Force, SAC, and JSTPS, we are applying artificial intelligence technology to greatly speed up the process of targeting our nuclear forces so as to be able to deal with mobile targets, if we can find them.

Besides information processing, our other major area of high-leverage technology investment is advanced materials. These include power sources, such as new batteries and fuel cells; structural materials like intermetallics, ceramics, and ceramic composites; optical and laser materials, and most recently manufacturing technology for high-temperature superconductors.

In ceramics, a new process for the shaping of ceramic composites was developed with support from DARPA by the Lanxide Corporation and jointly commercialized with Dupont. The effect of the process is to reduce the cost of ceramics by a factor of four, making production of ceramic composite armor for tanks and other armored vehicles practical.

In the area of high-temperature superconductors, as you know we are developing the processing and manufacturing technology for both bulk materials and thin film applications, and with special emphasis on microelectronic devices and sensors. We have made good technical progress over the last year, and we expect to help that field of endeavor through the support of several budding consortia. Our contractors established new records in critical current densities for both bulk materials and thin film materials for electronics. Over the next year or two we are on track to produce high temperature superconducting wire in mile lengths and with both the flexibility and strength for practical applications. We will also be producing our first quality SQUID magnetometers and IR sensors.

LOWERING THE COST OF DEFENSE

Over the last few years, DARPA has significantly increased its investment in manufacturing technology aimed at lowering the cost of defense, primarily emphasizing production of semiconductors, sensors, and other solid-state devices. Perhaps the most visible of those activities is the industry-government semiconductor consortium, Sematech. That project is now off on a good start. In a record 32 weeks, it has brought on line a fully operational, 48,000 foot, class-1 clean room for 0.5 micron devices. The first wafers have been produced in the factory with yields one would expect with quality contamination control.

We have a number of other semiconductor production projects developing technology that will feed into Sematech in the future. One is our work with Texas Instruments to reduce the major cost of microelectronics factory clean rooms. This is accomplished by use of vacuum modules and associated equipment that require only the small container for the microelectronics to be clean, not the whole factory. A second is our current work in x-ray lithography, the only practical technology for producing circuits with 0.25 micron or less feature size. Last year we developed new sensitive materials for x-ray lithography that can increase factory throughput by a factor of three, and we will be using that material to fabricate 0.5 micron and 0.35 micron circuits over the next two years. We are also doing work in excimer laser lithography, which promises to decrease the number of steps needed for microelectronics manufacturing by factors of four or five, thus significantly increasing yield.

Our program for developing manufacturing technology for millimeter wave and microwave monolithic integrated circuits, called MIMIC, is addressing a technology for which DoD is essentially the only customer, and a relatively small and unpredictable customer. The MIMIC program has already racked up some notable successes. A pilot line production of twelve different chip types with very promising performance is operational. In FY1990/1991, the first of two phases of the program will be completed, addressing automated testing, materials production, computer aided design and device handling, multi-chip electronics packaging, and brassboard insertion into a number of important DoD systems. MIMIC is the enabling technology for a broad range of DoD systems: transmit/receive (T/R) modules for radar systems, circuits for smart weapons and communications, wideband T/R modules for EW, receiver components for smart weapons and INEWS, to name a few areas.

Another important area we are pursuing to reduce the cost of defense is in simulation and training, where we have two programs that are making a big impact: SIMNET and Distributed Wargaming. In SIMNET, we have developed and demonstrated jointly with the Army, the technology for low bandwidth networking of a large number of low cost simulators, world-wide. Using SIMNET, large numbers of soldiers can be projected into a simulated battle in real time. We call it "artificial reality". The program has been a tremendous success and is being turned over to the Army for a major competitive procurement as the transition continues from research prototype to full development of an operational system. We are already looking at the next generation of technology by adding close air support aircraft and other weapons systems simulators to the network concept. We are also exploring the feasibility and practicality of vari-

ous levels of aggregation for realistic simulation of command and control through higher echelons.

The initial motivation for SIMNET was to provide realistic training to improve combat skills. This is increasingly important as the opportunities for training are restricted in Europe and the costs of training rise. But another use of SIMNET has arisen; namely, its use as an acquisition planning tool. We can develop low-cost simulators for equipment that does not yet exist, couple those simulators into the network, and measure the effectiveness in combat. We can modify the simulators to realistically see the effect of changes in design. And we can try out different tactics. There is no other means of evaluating the impact of new weapon systems in concert with the panoply of hardware on the battlefield. Measures of performance and effectiveness of SIMNET used in this way are still undefined, so careful assessment must be done before one draws too many conclusions about the results.

In conjunction with CINCEUR, DARPA has undertaken the development of a Distributed Wargaming prototype. Based on extensions of our computing and networking technology, the system is providing a simulated, command and staff, wartime environment for senior officer training in the art of warfighting. Under the auspices of the Warrior Preparation Center in Europe, an interactive, real-time, free play, distributed four corps wargame (more than 500 players) against an enemy-like, human opponent was conducted for the first time ever in December 1988 as a first step toward this prototype. An eight corps exercise is planned for November 1989. Air and ground commanders can work out the "game plays" that best use the talents and capabilities of their fighting organizations. By distributing the simulation through satellites, realistic training can be provided to geographically dispersed units. Equally important to DARPA, it will also permit testing of new and innovative military system concepts.

Another way DARPA is addressing cost reduction is through the use of more multi-mission weapon system concepts. We already have many multi-mission platforms in the inventory, and as resources become more limited and technology provides new options, there will be more. In a special access technology demonstration program, we are developing a different sensor concept that would enable a Lock On After Launch close combat multi-mission missile. The multi-mission concept enables two currently operational systems to be replaced in the future by one system that performs both functions. The obvious advantage is the reduced development cost and production cost due to larger production quantities, as well as savings in training and maintenance.

Advancing technology also permits more joint Service weapon concepts. In our Hypersonic Weapon Technology (HWT) program, we are pursuing a multi-mission joint Service air defense concept. This technology could lead to a common missile that could be launched from surface ship vertical launched systems, submarine torpedo tubes, and aircraft.

RESPOND TO MAJOR THREATS

There are six high-priority threats which have been a forcing function to concentrate DARPA resources and focus advanced technology on systems to counter these threats. The six threat areas and corresponding technology initiatives are: anti-submarine warfare, advanced aircraft countermeasures, armor/antiarmor, strategic relocatable targets, assured space assets, and low-intensity conflict.

Anti-Submarine Warfare: The Soviet submarine fleet is a severe, if not the most severe threat to U.S. tactical and strategic forces. The most troubling aspect of the threat is the fact that recent and expected new Soviet submarines are very quiet. The threat includes Soviet SSBNs operating in northern waters; submarines operating close to our shores with ability to launch cruise missiles; SSNs opposing safe egress of our SSBNs from port; SSGNs threatening survivability of our carrier battle groups and surface action groups from substantial standoff distances; and SSNs and SSGNs threatening the capability of our surface ships to reinforce and resupply NATO defensive forces.

As you know, we recently submitted a report, in response to a Congressional request, detailing this threat and a technology plan initiative that could have a major impact on our ASW capability in the future. I also understand that this subject, together with the related ongoing Advanced Submarine Technology program, will be covered in detail in hearings scheduled next month, so I will cover it only briefly here.

As part of our ongoing ASW technology initiative, DARPA is carrying out projects in nonacoustic sensing, acoustic sensing, advanced processing, unmanned underwater vehicles, and advanced torpedo technology. In addition, the Advanced Submarine Technology Program (ASTP) and Laser Communications efforts are important contributions to our future ASW capabilities and undersea warfare. Let me highlight a few of our accomplishments of the past year.

Our nonacoustic ASW program is looking at advanced radar and optical techniques for submarine detection from aircraft or from space. A major part of this is the radar ocean imaging program, which is a combined theoretical and experimental effort to resolve technical issues related to measurement of radar scattering from surface effects. The program is investigating new measurement techniques and processing concepts that show potential for improved submarine detection capabilities. In the past year, we have successfully conducted an experiment cooperatively with Norway that showed that a particular kind of multi-frequency radar, developed by the Norwegians, can detect strong internal waves produced by surface ships. Also, we have continued our analysis of data from our 1987 Loch Linnhe experiment with the U. K., along with theoretical work that leads us to some optimism that substantial improvements in detection performance may be possible.

As a spin-off of our investigation of optical techniques for ASW, we put together a laser system to detect shallow mines in the Persian Gulf. The system, which was designed, fabricated, and successfully tested aboard a helicopter, was able to search at high rates and to detect mines at the required depths with sufficiently low false alarm rates to meet the requirements for ship avoidance of shallow mines.

In acoustic ASW, we are developing technologies for robust, cost-effective, detection systems that will work against the difficult submarine threats of the 21st Century. Our goal to counter this new threat is to improve detection capability by a factor of 100. In order to achieve this, it is necessary to explore fully the detailed acoustic characteristics of the ocean as well as the full signature spectrum of submarines. In addition, it is essential to develop automated processing algorithms and systems and to demonstrate it all in sea trials. The major Navy effort in acoustic surveillance is at low frequency. The DARPA project focuses on mid-frequency. Our goal is to demonstrate an "ocean limited" array in FY1990 and advanced processing techniques for automated detection, classification, and localization by the end of FY1991.

This year an automated acoustic detection and recognition concept will be demonstrated in the laboratory using simulated and recorded submarine signals. An important part of the system is an acoustic detection system that uses a neural net processor. This processor was tested at sea with positive results and wide praise by the Navy. We have a long way to go before submarine sonars and undersea surveillance systems can be fully automated or, more likely, offer an intelligent assistant to the sonarman, but future ASW demands will lead to

large acoustic sensor networks that will only be feasible with the expected advances in automated processing.

Our prototype unmanned underwater vehicle design was completed and fabrication is well underway, and the mission package development and system integration contract was awarded. The UUV program has two principal applications. The systems to be prototyped will employ sophisticated sensors and control systems that will significantly enhance the operational flexibility and survivability of submarine platforms in hostile environments.

The Advanced Submarine Technology Program is accelerating the development of high-payoff technologies for submarines beyond the SSN-21. The program, limited to hull, machinery and electrical applications, is focused on improving submarine stealth, survivability, and payload while maintaining affordable costs. Significant strides have been made in what must be a long-term process. The establishment of an innovative technology base and infrastructure for future submarines has only begun.

Air Countermeasures Technology: The Soviets continue to improve their aircraft and missile systems capability for their general purpose forces as well as their strategic forces. Facing the potential threat of an effective U.S. strategic defense against ICBMs and SLBMs, the Soviet Union may rely more heavily on strategic bomber launched cruise missiles and submarine launched cruise missiles. Although the U.S. has started an air defense initiative, our defensive capability is already heavily stressed by their offensive capability and they could make this threat much more severe should they adopt some of the more advanced technologies for their air vehicles.

Most of our activities in this area are in special access programs. In addition to those, we are exploring a multimission air defense missile system in the hypersonic weapon technology (HWT) program that was mentioned previously. In that program, we are integrating several technologies into a weapons concept that would provide a long range intercept capability for defense of North America, outer-air-battle defense of carrier battle groups, and defense of our strategic bombers against long range Soviet interceptors. The enabling technologies are: high-altitude, long-endurance unmanned vehicles, hypersonic vehicle technology such as the SWERVE vehicle developed and flown by Sandia National Lab, the conformal radar developed initially under DARPA's LORAINE project, and the miniature GPS guidance system based on the GPS miniaturized receiver technology developed by DARPA. This GPS receiver is a major breakthrough that will

enable affordable proliferation of navigation, positioning, and guidance systems throughout the military forces.

Armor/Anti-Armor: In our Armor/Anti-Armor program, chemical energy warheads for anti-tank guided missiles (ATGM) were demonstrated to be capable of defeating the projected next generation Soviet armor. After infantry-operated, anti-tank missiles were proven so successful in the early 70's, the Soviets have developed means for upgrading the armor protection capability of their operational tanks in the field. The Soviets now pose a major challenge to NATO's ATGMs which number of the order of a hundred thousand weapons. The new warheads developed in this program can now be used to upgrade some of those anti-tank guided missiles and enable greater warhead effectiveness on new missiles. The Armor/Anti-Armor program has also made significant progress in kinetic energy projectiles, light armor, and heavy armor systems.

Advanced land combat systems have now been demonstrated to be valid and viable for future systems. Included are new survivability concepts which, when combined with advanced weapon concepts, will provide armored combat vehicles with a ten-to-one advantage over Soviet tanks projected for the early 2010's.

Strategic Relocatable Targets: The need to understand the signatures of strategic relocatable targets, especially the mobile ICBMs, is of crucial importance. We urgently need to understand the limitations of available techniques and to see if we can develop advanced sensor and sensor processing means for extending the capabilities as required to be able to hold these mobile ICBMs at risk.

An advanced airborne radar is being used to determine the detectability of strategic relocatable targets when those targets are partially obscured by trees. These radar signatures are also augmented with selected infrared optical data. The objective of our SRT program is to identify, develop, and demonstrate sensors that can detect, classify, and provide targeting information on land mobile ICBMs and other relocatable targets.

Advanced Satellite Technology: A Defense Science Board Summer Study of 1988 has brought to the forefront the growing concern that we must assure the availability of space assets in wartime. It would be particularly attractive to provide dedicated space systems and reconstitutable capabilities for use by tactical commanders. One way to achieve that goal is to reduce the size and thus the cost of the space systems and the launch vehicles. We are promoting

commercial launch vehicle development by procuring military launch services of these vehicles. Our first steps are to demonstrate available technology for space systems not heretofore available. This will hopefully be followed by the development of more advanced technologies and space system concepts and then their demonstration in space. To that end, a Broad Agency Announcement for advanced satellite technology is attracting wide-spread interest from industry and universities, and we hope to award multiple contracts to pursue some of the most promising concepts.

The PEGASUS airborne satellite launch vehicle design was completed and fabrication of the first vehicle has started. The PEGASUS vehicle will meet the low throw-weight end of our launch vehicle requirements. The airborne launch concept offers one option for a more survivable launch capability with flexibility in terms of first orbit ground track, and a more rapid response to theater space system requirements. The Standard Small Launch Vehicle (SSLV) will be developed to satisfy the payload requirements between the PEGASUS and Delta Class launch vehicles. Fabrication has also started on the lightweight satellite communications payload that will be launched this year.

Programmatically, we have signed or are negotiating agreements with all the Services to participate in the program. The Air Force will serve as primary, but not exclusive, agent. The Navy has had a long standing interest and the Army has a strong user involvement.

Special Operations and Low-Intensity Conflict: DARPA is playing a limited but growing role in the development of the special technology needed for low-intensity conflicts. In doing so we can leverage off our robust technology base in microelectronics and sensors for small, light, rugged inexpensive equipment oftentimes required in small quantities and with rapid response. We are involved in the development of the next generation of unattended ground sensors that are smart, are networked to work in teams, that combine the readings of many different kinds of sensors. We are using our microelectronics packaging technology to make systems, e.g. communications devices or beacons, that are 10 to 100 times smaller than before, and hence practical for foot soldiers. In addition, our small, high power-density battery technology, and work in compact night vision devices is also being directed towards the specific needs of the Special Operations Command (SOCOM). Final modifications are being made to the Advanced Tactical Transport experimental airplane to complete flight testing this year, and other small covert troop carrier aircraft concepts are being considered in cooperation with SOCOM.

I believe DARPA is in a unique position to provide R&D support to the Special Operations Forces by virtue of the technology programs we pursue and our streamlined mode of operation. General Lindsey and I have agreed to coordinate requirements and technology planning and a Memorandum of Understanding between DARPA and SOCOM is in final review that will formalize the agreement.

EXPLOIT TECHNOLOGY TO GAIN A MAJOR COMPETITIVE ADVANTAGE

Throughout most of its history, DARPA has been a driving force in pursuing technology in high-speed computers, microelectronics, sensors, automation, and unmanned vehicles, where we have a competitive advantage in exploiting the weaknesses of our adversaries. The "Competitive Strategies" plan may be new in form, but in substance, DARPA has been there all along. In common with this strategic thrust is the body of technology DARPA is pursuing aimed at improving manpower effectiveness and reducing casualties on the battlefield; namely, automation and "smart" systems, advanced sensors, unmanned platforms for air and underwater applications, and smart mines.

Over the past 15 years, DARPA has pioneered the development of mini- RPVs, now called Unmanned Air Vehicles (UAVs), for target acquisition, target designation, and target attack (e.g., air defense suppression). We reported last year the successful endurance demonstration with the AMBER (UAV) and the transition of this program to the UAV Joint Program Office (JPO). Because of budgetary limitations in the JPO, AMBER is in jeopardy. We decided to provide additional support to ensure successful transition.

We are now evaluating the Boeing Company CONDOR UAV development. CONDOR is a large, High Altitude Long Endurance (HALE) drone that can perform many reconnaissance, surveillance, target acquisition, and other C3 missions for the maritime forces, strategic forces, tactical forces over the friendly side of the battlefield, and for continental air defense (ADI). Boeing has had three successful flights with this fully autonomous aircraft and the results signal a new era in military aviation.

Just as in the case of UAVs, DARPA has pursued the platform, guidance, and sensor technology for Unmanned Underwater Vehicles (UUVs). As mentioned previously, a prototype UUV is currently under development for undersea warfare applications.

The Pilot's Associate program is applying artificial intelligence to decrease the workload in single seat combat aircraft while improving survivability and effectiveness. In FY1990, the program will enter the prototype phase. Our objective is to make this a real option for the ATF at Milestone II and to provide for product improvement of other aircraft. The basic technology and concepts can be applied also to helicopters, submarines, and surface ships. Using a manned simulator, we have demonstrated the Pilot's Associate ability to help the pilot to perform a fighter mission in an extremely high-threat environment. The demonstration was not done in real-time, but in a reconstruction that allowed demonstrating real-time rates, very impressive performance was shown. Achieving real time performance is the principal challenge in the program and we have identified the steps to achieve that goal. This year we will demonstrate in the simulator the capability of the system to fit a real scenario, but not in real time. We will then start the prototype program in early FYI990 and by the end of FYI99I, we will demonstrate real-time performance with brassboard hardware.

Our Smart Weapons technology program offers a vivid example of competitive strategy implementation. U.S. strengths are in sensors, sensor processing for target recognition, and survivable autonomous air vehicles. Smart weapons will combine those technologies and focus them on an enduring Soviet/Warsaw Pact weakness -- their doctrine to employ mass armored forces in successive echelons to break through NATO defenses. This doctrine works only if the rear echelon forces are free to maneuver and have good command, control, and communications. As a result of earlier DARPA programs like Assault Breaker, SACEUR developed the Follow-On Force Attack (FOFA) strategy that was adopted by NATO.

Our smart weapons program provides the next generation of FOFA weapons. Whereas, Assault Breaker was concerned primarily with attacking armored combat vehicles, the smart weapons will be focused on the extremely high value targets, such as: Tactical Ballistic Missiles (TBM's); mobile command posts in the rear echelon regiments and divisions; and other critical communication nodes. All of these targets can be protected, concealed, and camouflaged. Many of these targets will be found in forested areas where they are difficult to detect under foliage. The multisensor suites processing concepts that we are developing are aimed at being able to "dig" those targets out of the clutter. This year we will demonstrate real-time, multisensor search and automatic recognition of these difficult targets.

Application of our advanced target acquisition technology program is another way to exploit U.S. strengths and focus it on an enduring Soviet weakness. Much progress has been made in theater target acquisition through the Joint STARS program. Even with JSTARS, however, a dedicated reconnaissance, surveillance, and target acquisition (RSTA) capability is needed in the Army to serve the Corps Commander and Division Commander as well as brigade and battalion levels. We are currently working with the Army and with European commanders to better understand the needs, the limitations of existing capabilities, the technology and systems options for the future, and the architecture within which a dedicated RSTA capability should be inserted. We are planning for a significant effort to develop and demonstrate the technology beginning in FY1990. In addition to the program definition and study effort, we are continuing the testing and demonstration of a battlefield moving target indicator (MTI) radar that was developed for use on UAVs. This lightweight, relatively low cost radar can effectively complement JSTARS by providing a capability to lower levels of command.

Following recommendations of the Defense Science Board Summer Study of 1986, DARPA initiated a smart mines program concerned with land mine and countermine warfare. The program includes the development of technology and concepts for wide area, smart, controllaole mines, mine detection techniques for countering land mines, and anti-helicopter mines. Mines can be very effective in defense, but in classical form can be a hindrance in counter offensive operations. A potential solution to this problem is the capability to control mine fields by turning them on and off. We believe this is possible in a way that defies enemy countermeasures. We can also increase the effectiveness of mine fields by providing networks of mines with extended area or wide area mine concepts. We are currently in the competitive concept definition and exploration phase of the program. In FYI990 and FYI99I, we will advance to technology development and demonstration phases.

While not in the same vane of automation and unmanned systems described above, our program to exploit the performance advantage of high angle of attack maneuverability for fighter aircraft offers a decisive edge in air-to-air combat. Fabrication of the X-31 aircraft which will demonstrate Enhanced Fighter Maneuverability (EFM) technologies has begun. The X-31 EFM project, which is one of our Nunn Initiative efforts, is a cooperative effort between the U.S. and Federal Republic of Germany -- the first international x-airplane program. This experimental aircraft will demonstrate a new concept for achieving the advantage in short range, air-to-air combat even when out-numbered by two or three

to one as U.S. and NATO forces would be. The aircraft design was completed by the U.S. and German prime contractors (Rockwell and MBB). Final assembly of the first aircraft was initiated in November. A second aircraft is also under construction. The program started in FY1986 and first flight is scheduled in the first quarter of FYI990.

This project is crucial because of the evolving Soviet threat which will make beyond-visual-range air combat much more difficult in the future. Without enhanced maneuverability, the short range air-to-air combat advantage belongs to the side with the largest number of aircraft. U.S. and NATO strategy has been to maintain a major advantage in beyond visual range so that when the battle closes to short range, the NATO forces would out-number those of the Warsaw Pact. In the future we must have a way to win in close combat even if out-numbered. Enhanced maneuvering agility may provide this. Results of the program will be valuable in designing maneuverability improvements for current aircraft (e.g., Agile FALCON) as well as for design of future aircraft to succeed the F-I6s and F-I8s, and beyond that, much of the technology feeds directly into concepts we are exploring for short take off and vertical landing (STOVL) aircraft. In our Advanced STOVL (ASTOVL) program, also a Nunn Initiative, we are working with the U.K. and with NASA to explore technologies and advanced aircraft concepts that combine increased survivability on the ground with high agility and survivability in the air.

TECHNOLOGY FOR TREATY VERIFICATION

Since 1958, DARPA has been chartered with the development and demonstration of advanced technology for detecting, identifying, and measuring nuclear events to support verification of international test ban treaties. We have supported the development of the world's most advanced seismic sensors and phased arrays of such sensors, signal analysis and nuclear yield estimation methods, and nuclear radiation detection technology.

Last year we demonstrated the second of three high frequency phased arrays of seismic sensors that are installed in Europe and we began development of the technology for a network of monitoring stations that will be deployed within the USSR. The analysis of the data from these phased arrays and later the entire network will be accomplished by computer systems utilizing artificial intelligence methods to aid in the separation of nuclear events and earthquakes.

We have expanded our support for treaty verification through the development of ultra-sensitive chemical detectors. These could be deployed for field

use to provide early warning of sublethal concentrations of toxic agents; or could be used for strategic intelligence -- CHEMINT -- to detect the manufacture of CBW agents. One of our recent sensor developments using biotechnology to achieve both remarkable sensitivity and specificity in responding to toxic agents has been licensed by our research contractor to Dupont to provide a commercial supply for the Services.

With these five strategic thrusts, I have described the core of our program. But in an organization like DARPA, we must always be planting seeds for the future. To that end we are providing a small amount of funding for a number of highly speculative concepts with the potential for very high payoff. One is our investment in charged particle beams for tactical applications. We are trying to understand the physics of beam propagation through the atmosphere so as to increase range, and to design and develop particle accelerators that are sufficiently small and light for tactical use. We have programs in neutrino detection, optical computing, biotechnology, applied mathematics, robotics, microsensors, and high efficiency propulsion and power to mention a few.

## BUDGET

Our budget request for FY1990 is $1,120.8 million and for FY1991 is $1,164.0 million. I would like to make a few points about these budget levels. First, basic research, or 6.1 funds, accounts for $110.1 million, or 10 percent of the total and we have held it at that in FY1991. I consider our investment in basic research critical for the long term vitality of DARPA, and that is true for DoD as a whole as well. There is no "right" level that can be justified, but I consider the 10 percent level to be appropriate and will protect it from being reduced below that. Second, in FY1989 DARPA's mission was expanded to include new initiatives in manufacturing technology. Specific programs and the accompanying budget as well as personnel were transferred to DARPA from Defense Research & Engineering to support the additional responsibility. We welcome the additional activity as important to Defense and well suited for DARPA, but I would not want the Congress to look just at our "bottom line" budget and conclude that we have sustained significant growth without new responsibilities. Third, we have established a program element for prototyping advanced technology and innovative concepts. This was prompted by a desire to give increased visibility to this important activity, even though it is currently funded at a modest level, and also to raise "accounting barriers" to protect

other research important to DARPA's traditional mission. I should add that under the President's new guidelines for the Defense budget, these budget figures may change.

IMPORTANCE OF THE ROLE DARPA PLAYS IN DEFENSE R&D

In DARPA we move out ahead of formal requirements to develop advanced technology, pursuing the risky course usually shunned by others. And we move quickly, in order to capitalize on the technology advantage we seek. We have little bureaucracy and little overhead, and we hope to continue to be the small agency that makes a big impact. With 1/3 of 1 percent of the Defense Budget and with an insight into Defense needs, DARPA is encouraged to look for imaginative solutions in advanced technology, unconstrained by traditional thinking and approaches. It is a relatively small investment and a very important role we serve, and I think the Nation gets its money's worth.

We have had a good year. But we are stretched thin and we are facing a growing crisis in recruiting and retention of the quality science and engineering management talent we need. I said that last year and nothing has happened to improve the situation.

Despite these problems, we intend to continue to provide cutting-edge technology for defense, and we look to the Congress for continuing support.

Mr. McCURDY. Thank you, Dr. Colladay; as always, a very comprehensive review. Many times I think you realized that you're probably speaking to the choir here. We have always been very supportive of DARPA in this subcommittee and probably in the Congress. You'll probably find more friends here in the Congress than you do across the river.

We are concerned about where DARPA is headed. I am curious, at the outset, about the overall spending levels. The budget that I have in front of me is your pre-Bush budget. Is there a post-Bush bogey out there? If so, what is your target and what do you anticipate having to adjust?

Dr. COLLADAY. Mr. McCurdy, we haven't finalized that budget. We do have some bogey numbers we're working to. I wish they were higher than our current budget but, as you know, that's usually not the case—and certainly not in this instance.

I suspect that our budget for fiscal year 1990 and the runout will see a further reduction of around 2½ percent, or pretty much within the overall Department levels of reduction.

Mr. McCURDY. If you're coming from an inflation plus 2 percent budget to an inflation percentage, we're still talking 2 percent, so your max would be above the 2 percent level.

Is the rest of the Department getting 2 percent or is it all 2.5? Do they basically come and say, look, everybody's going to take their fair share across the board, 2.5 for everybody?

I know you're trying not to be too specific here, but——

Dr. COLLADAY. It's more or less across the board. I mean, it's based on a reduction from the levels that we had in the Reagan budget, which for us was already down from the 1989 level, so we didn't share in the 2 percent growth.

Mr. McCURDY. You may not get the 2 percent over the previous budget.

Dr. COLLADAY. But we're sharing in the reduction.

Mr. McCURDY. OK.

You indicated that you had the 6.3 moneys for prototying, which historically not been in the mission of DARPA. I understand the Packard Commission made that recommendation.

Is that something you welcome or has that been a burden? What is your view?

Dr. COLLADAY. It can't be implemented without additional resources. That's been the problem that we've had in moving out as aggressively as we would like.

Mr. McCURDY. You said you had cordoned your 6.3 off funds. What amount do you have?

Dr. COLLADAY. It's about $100 million.

Mr. McCURDY. Staff says 94.7?

Dr. COLLADAY. Yes.

Mr. McCURDY. That's something you've taken basically out of hide that's not been an add-on?

Dr. COLLADAY. No, we did get an addition—it depends on how you want to do the bottom line accounting. But there is the Pilot's Associate program that was approved in the 1990 budget for $25 million. That's a 2-year effort, fast track, in order to have the technology demonstrated by the end of 1991. So it's a 1990–1991 effort.

Mr. McCURDY. I have a range of issues I want to quickly cover.

One issue that I don't think was mentioned that I looked for in the testimony, was one that has attracted a great deal of international attention within the R&D circles, and that is high resolution television.

I know that French Thompson are making big investments; the Japanese are pouring a lot of money into this; not strictly for DOD application, but as the next generation of commercial products as well.

What's DARPA doing with high resolution television? Do you see this as an area that has potential? If so, how much money are you putting toward it?

Dr. COLLADAY. I think it does have potential in several areas, and that's why we're motivated to put some resources into the area, and I'll let Dr. Craig Fields address it in a minute.

The Defense Department is a major user of displays, and large displays where high definition is important. There's another reason, of course, why we think that is an important area, and that is related to the tremendous market that high definition displays—high definition television—will open up in microprocessors semiconductor manufacturing.

Mr. MCCURDY. High definition displays will be a large consumer of semiconductors?

Dr. COLLADAY. That's right. Now, the high definition display technology that we were investing in is just an integral part of our computer technology and electronic sciences, so you don't see it as a separate line in the budget, but I'll turn it over to Craig to address some of these.

Mr. MCCURDY. Craig, before you begin, and because it's really a related subject, you've got the high definition displays, but then you also have money for superconductivity. The reason I personally link those together is that both are tests of future U.S. competitiveness in a wide range of applications.

I am interested, and I think the subcommittee would be interested, in how the consortium are working. That is, whether the interface between the Department of Defense, the Department of Commerce, and NIST, and NSF, and all the other Federal agencies out there and the academic community and industry is working. Is this a good model and something that we ought to support, being one who supports a civilian DARPA, or are we getting beyond the scope of your Agency?

Dr. COLLADAY. I think it is working reasonably well on an ad hoc basis. We're involving the Department of Commerce through NIST, NSF and other agencies in helping us evaluate the proposals that are coming in on high definition displays. Incidentally, the Broad Agency Announcement just closed yesterday. We are going to set up an evaluation team that will involve all those folks that are interested in the technology.

We're working with them; we're coordinating our efforts—and I think that's good. It's happening without any formal structure, and I think that's good, too, if it works this way. Then if it isn't broken, don't fix it.

Mr. MCCURDY. Dr. Colladay, it works if we see the results. It's hard to tell at this stage who's ahead and who's on first. The only discernible measure, other than getting into each R&D project, is

seeing how much funds are being invested by the relevant countries and other parties.

The amount of money we're investing in both superconductivity and high definition displays is minimal compared to the Japanese and Europeans; is that not correct?

Dr. COLLADAY. That's correct, particularly in high definition television and high definition displays. That's a much bigger issue than DARPA's small investment can address.

In terms of superconductivity, I think we are comparable in our investment with Japan. Maybe we're not moving out as fast as we'd like—DARPA is, particularly because we're focusing on processing and device technology and not waiting to do it serially until the materials come along.

I would like Dr. Fields to address some of those points. I know he has a view as well.

Dr. FIELDS I think I'm going to start from the top and work down because you raised a large question of two things: one is how are the consortia going; and second is how are things going across the executive branch and getting some people to work together.

I think both are actually pretty good. If you look at Sematech, in a very short time, just a few weeks—32 weeks—they got a Class I clean room for 0.5 micron devices—48,000 square feet up and going factory. They have produced the first wafers, and they have been getting some good results—and I'm pleased about that.

We have been working with the Department of Commerce. They did a review of our management of Sematech, which sounds a little peculiar, but nevertheless, they did. I brought the report with me today just in case someone asked. In fact, they came out with really glowing reports about how things were going and urged that the activity not be moved out of the Defense Department but, in fact, stay exactly as it is and just keep going.

I also invited Commerce, incidentally, to provide us with a deputy program manager to be on-site dealing with the Sematech program, with only one request—whoever it is should have a professional career in semiconducting manufacturing because they've got to know what they're doing. That's the request they have, and I hope that they are going to come forward and give me a positive response.

In the area of superconductivity, we're working now with two consortia that have submitted proposals to us. We have given hand shake agreements to support both of them. That will give some leverage for them and leverage for us, and I think it's quite a good thing to do.

So I think the consortia model is working, and I think across the executive branch things are working reasonably well. You put your finger on an important issue, namely, the overall level of support, because you can only do much by organization, you have to have a stake in the work. That's what I'm zeroing in on and what you were zeroing in on as well.

Let me go now to the question you asked about high definition displays and say a few words about where we are. As Ray correctly said, our procurement closed yesterday; we received over 50 proposals from U.S. industry. There are some striking things about the

proposals that I think are worth noting and I just want to mention a few of them.

One is that, by and large, these were not proposals from individual companies, but from teams. Basically, companies chose to create strategic alliances that didn't exist before in order to work together.

Today, AT&T and Zenith, for example, put out a press release announcing their strategic alliance—and those are two powerful companies representing different interests that have to be combined to really deal with this issue, so I'm very pleased about this teaming that's gone on in a natural way.

Second, there's a tremendous amount of cost-sharing offered by the industry. This isn't a sort of handout, please pay us issue, but rather, one in which they are meeting us more than halfway, and I'm extremely pleased about that.

Third, by and large, the proposals are not zeroing in uniquely on high definition TV, but in fact, are quite smartly emphasizing the components, the displays, the semiconductors, the electronic assemblies, underlying high definition display systems, and other things like intelligent work stations, personal computers, and in part, even things like laser fax machines and digital copiers. So that more industries than just the HDTV industry are affected. In addition, people are looking at applications of those components, namely, to HDTV—so I was pleased about that.

As I already mentioned, we have invited a joint team from across the executive branch to oversee both proposal selection and subsequent management because it seemed that they should take part. We've gotten acceptances from Commerce in writing; from NASA as of today; from the FEC, and from NSF, and others will be joining as well. So I think that's an important thing to do.

I have discussed matters with the FCCSET Committee, the Federal Coordinating Council on Science, Engineering, and Technology, to get their agreement that this would be done under their umbrella because that's the formal mechanism for doing these things. Frankly, we just have to move out on the real work before we get the formal mechanism in place, and that's going along quite well.

So that's about where we are on that issue, and I hope it's going to go quite well.

Mr. McCURDY. Very good.

I am going to recognize members in their order of appearance.

Before I get to that, Dr. Colladay, I am not going to ask you to respond right now, but at some point I'd like to ask you whether or not the threat to turn off Landsat's IV and V by the end of the month is in the United State's best interest. Also to give a comment about the Air Force's reduction in NASP—aerospace plane support. At some point, I would like someone to give us an update both on the RPV and how well the Joint Program Office on RPV's is working. Also, whether or not AMBER was a wise decision; and an update on the KEW anti-armor.

I want to get those on the record, and for you to answer those at some point.

[The answers were provided during the hearing:]

Mr. McCURDY. The gentleman from Virginia, Mr. Pickett, is recognized.

Mr. PICKETT. Thank you, Mr. Chairman.

We hear a lot these days about business concerns in this country and organizations focusing so much on the near-term and not planning and executing for the long-term.

How do you see this impacting on your agency, and are you falling victim to this same sort of thing, that is, stressing too much near-term results at the expense of long-term benefits?

Dr. COLLADAY. Mr. Pickett, I don't see that as a problem that DARPA has experienced. Over the years, DARPA has been focused on the long-term and the industry that works with DARPA is as well pursuing technology that really is far out in timeframe.

The technology that we're working on is really geared to weapon systems typically 10 years in the future, or longer, given the time it takes to develop the technology and go into full scale development and production. But we do see it across the board.

I think your basic thesis is a correct one in that more and more organizations, both companies and in the Government, are being drawn more near term, and that should be a concern to all of us.

In addition to that, there is more and more reluctance to take risks to pursue the risky approach that DARPA tries to pursue. We fail sometimes, but we fail because we reach too far when we do—and it's still all right to do that. That's not a view that's shared by very many organizations, it seems, in the country today.

Mr. PICKETT. You mention in the strategy that DARPA uses that you tend to focus your resources in those areas where you perceive that this country has the technological edge. I guess the counterpart of that is, in those areas where the other side has a technological edge you're not pushing as hard.

Doesn't that run the risk of a breakout in some area we're not prepared to respond to?

Dr. COLLADAY. We try and make sure that we are aware of those situations. That's primarily what's the underpinning of those six threat-driven technologies where we do see a change in the balance between our capability and adversaries. So we try and look at both of those angles in our basic investment strategy.

DARPA was created—and its charter is to avoid technological surprise. It was formed because we were caught short in the days of Sputnik where we had fallen behind and were surprised, and that is an important part of DARPA's mission.

So we don't think we overlooked that. But we do stress the areas of competitive advantage, too.

Mr. PICKETT. My final question. I notice that you say here on page 2 that through your sponsorship of university research, you support nearly half of U.S. graduate students.

How many of those graduate students are non-U.S. citizens?

Dr. COLLADAY. That's a good question. I'm not sure I have the answer. Dr. Fields, do you know?

Dr. FIELDS. We are not able to get, as I am sure you can expect, a sort of national breakdown from universities as to which graduate students are supported. If the statistics for computer signs were the same as the national statistics from the National Science Foundation, then round numbers, half of them would be from other countries and half would be from the U.S. That's not to say that the

half gathered from other countries all leave the United States after getting their degree and go back. That's a separate issue entirely.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. MCCURDY. The gentleman from New York, Mr. Hochbrueckner.

Mr. HOCHBRUECKNER. Thank you, Mr. Chairman.

Dr. Colladay, on page 8, I find the only reference to x-ray lithography in your document. Your statement says it's the only practical technology for producing circuits with a quarter micron or less feature size. We've been through this over the last couple of years. Obviously, I know DARPA's interested in the program, excited about the program, and certainly it fits most of your five thrust criteria, so to speak.

My concern is, we've put $46 million into the program over the last 2 years; and this year it needs between 44 and $50 million in order to continue the effort in order to be competitive and produce the next generation of computer chip. So I am disappointed that in the budget there's no money for x-ray lithography.

Do you have any comment? Do you have a secret pot someplace where you can reveal to me that the money will be found? Is there any hope from the executive side?

Dr. COLLADAY. I wish I had some money squirreled away, Congressman, that I could put against a very important program. I agree with everything you said. We've tried to address its importance with the Sematech consortium, and I think in the long term that's an avenue that is going to be fruitful. The problem is in the short term, and most specifically, in the fiscal year 1990 budget.

The level of effort that we think is required is in line with the figure you mentioned. We simply don't have the resources to put against it that is equal in size to all the money that we have in advance materials. It's twice as big as the effort in superconductivity. It's half as big as the whole 6.1 Basic Research base, and the resources were just not forthcoming that we could put against it in fiscal year 1990.

It is terribly important that we find a way to keep that effort going and we are going to do everything we can, short of printing money, to be able to do it—but it is a concern.

Mr. HOCHBRUECKNER. So you wouldn't be disappointed if it was a legislative put-in for the third year in a row, I assume?

Dr. COLLADAY. I think it's an important area, in a very high priority area.

Mr. HOCHBRUECKNER. The second area is—I've been doing some homework on the infrared focal plane array area, and it seems to me there's a great opportunity for savings in that area by proceeding with the that program. I notice in the budget provided—that there's a $33 million listing. But I understand that's been cut to 23. Is that the status at this point?

Dr. COLLADAY. That is part of our internal planning and budget decisions regarding the new budget targets that we have been given to get down to no real growth in the 1990 budget. Those decisions haven't been made. That has to go through a defense budget review board—and that will be happening over the next several weeks.

Mr. HOCHBRUECKNER. Mr. Chairman, just one further comment.

Another area that I've been looking into that seems extraordinarily promising, which falls in the DARPA area, is this new revolutionary combustion engine, that apparently Engine Corporation of America is providing, which has much higher thermal efficiencies. Obviously, if that is true, the engine offers great opportunities, both from a military and clearly from a commercial side. Obviously, if we could, in fact, encourage the utilization of an engine with much greater higher thermal efficiency, clearly the impact in terms of reduced pollution, greater gasoline efficiency, what have you, would be tremendous.

I understand you folks are going to make some presentations shortly to me and I just want you to know that this seems like an area of extraordinarily good investment, and one that fits a lot of the criteria in your five primary thrust points.

Thank you, Mr. Chairman.

Mr. MCCURDY. I thank the gentleman.

Now that we've made that round, let me get you to answer some other questions.

First of Landsat, NOAA sent around a memo worldwide that unless an additional 9½ to $10 million was found to take them through this fiscal year that they would turn out the lights and turn off Landsat, which strikes this member as an appalling decision considering in the early 1970s we had a complete monopoly on that technology and then we moved toward privatization. We're now looking at R&D on Bird 6 and 7, and development of the next generation of sensors.

Some of us warned the Department, the intelligence community, and other people that some day they may be coming back to us and saying, we need this technology, or this data, and we may end up having to purchase it from the Japanese or French, which appears the way we're moving.

Would you care, drawing on both your experience in NASA and the Department of Defense, to give us your view on that?

Dr. COLLADAY. Mr. McCurdy, I didn't know that that was in the offing in the NOAA budget. It strikes me as a very discouraging development. I know that these systems are expensive to operate, and the operational costs come year after year after year, but given the investment that was made in putting that capability in orbit, it seems to be penny-wise and pound-foolish to do that.

Mr. MCCURDY. The irony is that it wasn't programmed because the satellites are actually lasting longer than they were originally programmed—so much for that. But that is certainly a foolish decision.

I would appreciate if you would take that back with you. I met with the Vice President on that subject today—he's interested, and I know others within the Department are concerned about it as well.

Tell me about the NASP, and I realize that you're no longer the lead agency on it but you're still involved in the joint program. What's the funding and what do you anticipate if there is a reduction in funding?

Dr. COLLADAY. I am not aware specifically of the funding level that is being targeted for any recent reductions.

Mr. MCCURDY. I don't have an exact figure but I will tell you this just for your information.

General Welch was in the other day and indicated that it, like all other, "Air Force systems or anyone else's, any other thing" would take their, "fair share." That's all we're hearing these days is "fair share." with or without—Gramm or Rudman.

Where are we as far as the progress on NASP and the unique joint working relationships that the teams have put together, and what would you perceive if we were to slow that down?

Dr. COLLADAY. It seems like it's a fragile coalition, doesn't it, between NASA and the Air Force and others, because the payoff is as viewed by some people, so long term, that it, unfortunately, comes under the magnifying glass in budget-cutting time. But this is precisely the time that I think we need to have the staying power with stability in funding, particularly over this next 2 to 3-year period where I have consistently said the program is going to either fail or succeed on our progress over the next 2 or 3 years.

It can probably take a small scale back in funds if that's absolutely necessary because it's made up currently of a lot of technical efforts in leading to the decision for Phase 3.

So it depends on how big the cut is. I think 2 to 3 percent—if that's the fair share—could be reasonably accommodated with some stretch-out. It's a technology paced program and that will just slide things out a little bit.

We can't nickel and dime it and cut it in a major way if we want to keep the discipline of the contractors focused on a real decision point. If that decision for Phase 3 becomes an unreal thing that people are striving toward, then I think we're kidding ourselves that we're going to be able to successfully complete the program.

Mr. MCCURDY. One of the problems is that anytime you have a program that has both military and civilian applications and it's not exclusively military or doesn't, "drop bombs," then sometimes it doesn't achieve the support or have the type of support that it deserves.

If there's any system out there today or any R&D effort that's going to break new ground in materials and in propulsion, which could eventually lead to a whole new generation of transport, it's NASP. Which, by the way, we see today aircraft are still our largest single percentage of foreign trade surplus that we have. If we lose that in the next decade or beyond, then we're really going to be in budget constraints. This one that I would urge the Department to continue to support.

You mentioned JSTARS and we may not be able to do it in this session, but what portion of that program is the DARPA's involved, and what is the status.

Dr. COLLADAY. We're not involved in the program specifically at all, Mr. McCurdy. What we are looking at is systems that can be a complement to JSTARS for reconnaissance, surveillance, target acquisition at the division and brigade level.

Mr. MCCURDY. Other types of systems or just complementary to JSTARS?

Dr. COLLADAY. Other types that are complementary to.

Mr. MCCURDY. It's always difficult to get the Europeans and NATO Allies involved in the program as long as they see us push-

ing it. But if support for that lags, then it may create other problems, too.

I was at White Sands and watched one of the test flights of the kinetic energy weapon. The Army's acronym is KEW. It's a truly mind-boggling technology to see something move that fast.

What is your evaluation of the status of that and how is it progressing?

Dr. COLLADAY. I think it's moving very well, pretty much on schedule, and cost. I think Bob has something more that he might want to add to that. Bob?

Mr. MOORE. As you know, Mr. Chairman, that program has not ever been fully funded. There was a joint program for the hypervelocity missile that was funded through the Air Force with some money from the Army budget and some from the Marine Corps and some from the Air Force. The Air Force interest was in a slightly smaller weapon, but still anti-armor.

The company has put a lot of money into it. We are just, I think, with the Army, under the AAWSH program, advanced anti-armor weapon system heavy, beginning to define a healthy program.

Now, there have been some problems with the program: some missiles have flown; there's been human error, tape left on a fin, and so forth. But from my perspective on the program and my technical judgment is that there's no fundamental reason why that kinetic energy missile will not work. I think we have to make it work. The reason we have to make it work is that the Soviets are now in the process of upgrading their existing tanks by placing on those tanks reactive armor that can defeat virtually every anti-tank guided weapon in NATO; and that measures up to the order of 100,000 weapons.

So we must get a kinetic energy kill mechanism in the infantry anti-tank forces. This is the nearest term way to do it. Yes, there are some risks, but I think it will work out. There are some risks in the fire control system, and the energy that we get with a hypervelocity missile, propelled by a rocket, versus a gun, is of the order of three to four times what we can get from existing power guns. We must pursue that.

We see no way that in the foreseeable future that this weapon system can be defeated by anybody's armor. We just must do that. So it is imperative to figure out together how much the program needs to be healthy and to make sure that it's fully funded.

Mr. MCCURDY. I was somewhat disturbed to see the letter to the committee in reference to the Advanced Submarine Technology funding which has, again, not been provided through the Department. The appropriations in the last few years has been close to $100 million.

Is the Department just expecting Congress to put it in again or is there any technical reason why you should not be conducting this research?

Dr. COLLADAY. Quite the contrary; there is no technical reason why the program isn't a good one. It is proceeding along the original implementation plan. We are fully under contract for fiscal year 1988; fully committed for all the fiscal year 1989 resources.

It is advancing the technology base in a healthy and robust way with a lot of new contractors involved in looking at the advanced submarines and the missions of the submarines in the future.

Boiled down to an affordability problem, we started the program at the direction of Congress with roughly $112 million from the Navy; and then in fiscal year 1989, $95 million appropriated directly to DARPA. In fiscal year 1990, we did not get the resources approved by the Secretary to continue the program.

Mr. MCCURDY. Was the request made by DARPA?

Dr. COLLADAY. Yes, it was.

Mr. MCCURDY. So it's the DDR&E that made the decision?

Dr. COLLADAY. It went all the way.

Mr. MCCURDY. It went all the way beyond that.

Because of a number of committees that I am on, I'm very concerned about the ASW mission. I'm concerned about the moneys we prioritize in that arena. ASW cuts two ways. It's not just U.S. ASW efforts. I think we need to be extremely aware of potential technology developments. If we can spend billions on SDI—and much of the justification is to prevent a breakout, then I can assure you, we should be spending a great deal of money in preventing ASW breakouts. At least we should know where the technology is going.

That's something that this subcommittee, I am sure, will be reviewing and revisiting.

The gentlelady from Maryland. Mrs. Byron.

Mrs. BYRON. Thank you, Mr. Chairman.

It looks like that I have been designated as the personnel person on R&D and following along on those lines, in which I have asked questions in those areas to previous panels.

Mr. MCCURDY. There's no better person that has the qualifications than the gentlelady from Maryland.

Mrs. BYRON. Let me follow on in your testimony that you are concerned that DARPA has serious retention and recruitment problems. The situation in obtaining and keeping people to manage the high technical programs is one that I think concerns all of us.

Could you, off the top of your head, give me a rough number of employees that you have?

Dr. COLLADAY. We are currently at around 160 people now—73 technical managers——

Mrs. BYRON. Seventy-three technical?

Dr. COLLADAY. Yes. With a complement with an ability to hire up to 90 technical managers.

Mrs. BYRON. Are you short 17 because you can't find the personnel?

Dr. COLLADAY. So far, that's correct. I have a number of recruiting actions under way. It's very difficult to attract the kind of people that——

Mrs. BYRON. Of the 73 that you currently have, how many have left over the past year?

Dr. COLLADAY. We have a fairly high turnover rate because we encourage it. DARPA is not a place where we want people to spend a career.

Mrs. BYRON. To homestead?

Dr. COLLADAY. That's right. When I hire a new person—when I talk to every new person that comes to DARPA, the first question I asked them is what do they plan to do when they leave, because I want——

Mrs. BYRON. Do you then follow it up with, how quickly do you plan to leave?

Dr. COLLADAY. I point out to them that the ideal tenure of a DARPA manager is 3 to 5 years. We pretty much follow that. We have some old-timers—I won't go into names—that have been there for a while. We have some that leave that are extremely effective in their job that leave too soon. In the case of one, we've had to replace—we're going to have to replace after 1 year, the Director of our Aerospace and Strategic Technology Office.

Mrs. BYRON. Did that have anything to do with the pay issue?

Dr. COLLADAY. No, in that case it didn't. It was an opportunity for career advancement, and, of course, we encourage that. But we have a number of recruitments under way right now.

Mrs. BYRON. What I was going to ask next, and you've touched on. You encourage a 3- to 5-year timeframe.

What do you find the average stay has been? Has it been less than that?

Dr. COLLADAY. I think that's about average. Maybe Dr. Fields would like to comment on that.

Dr. FIELDS I think the average is about 3 to 5 years.

Mrs. BYRON. So then you're not having a problem with that aspect of the recruiting. When you do recruit and you get people within DARPA, they are staying the timeframe consistent with your guidelines?

Dr. FIELDS There are really two issues, and you can't see them in the statistics that easily—three issues. One is the time delay in filling positions because we want to maintain the quality standards. On the other hand, it's getting harder to harder to do that as a consequence—as reported to me when I talk to people who might come of the salary differential, which is getting larger and larger. So that's really quite a large issue for us.

Also, I gave you a three to five answer correctly, looking over perhaps the past decade. If you look over the past recent times, or the past year or so, I don't know what the statistics say, but I'm pretty unhappy. We had a great applied mathematician working on algorithms for power processors and she ran off to work at Lockheed. I asked her about her new job and she started off by telling me about the salary. That wasn't good.

Then we had a great guy in charge of our opto-electronics program. He went off to du Pont. I asked him about his job and that's exactly how he started the description too.

So with a small size like our place, it's sort of hard to do statistically, but you get a feel for it when you talk to the individuals. You get a much bigger feel when you talk to people and try to get them to come and they just say no.

Mrs. BYRON. How many people do you have working on recruitment? Because when you have a small number to start with, if you have to dedicate a good number of those individuals to work on recruitment, that reduces your productivity.

Dr. COLLADAY. It's in everybody's job.

Mrs. BYRON. Everybody recruits?

Dr. COLLADAY. Everybody recruits.

Mrs. BYRON. You mentioned in your testimony the advanced computer technology that's going on at DARPA.

What chance does a young, curious genius have to get into your computer systems?

I think many of us are very concerned about the new potential for a computer virus taking hold in some of the arenas.

Dr. COLLADAY. It's a threat that we're taking very seriously. There are many different ways to defend against that threat. Many of them are not very suitable for a research network like those that DARPA has developed, because we want to involve university researchers and research communities across the country. But we're looking seriously at that in some of our advanced research and networking.

We formed, as a result of the virus problem that we encountered in November, a computer emergency response team that is a network of experts around the country that's being managed out of the Software Engineering Institute at Carnegie Mellon. It's already been pressed into service and is a very effective tool to respond to these kind of threats. It's being used as a model for other similar response teams that are being developed for other networks. The National Security Agency and the National Institute of Standards and Technology are cloning that system for their use as well—other response teams. The research that we're doing is addressing security.

One thing that experience has taught us is just how vulnerable we are to these kind of penetrations. To that extent it was a useful lesson to learn, but it's a difficult one. We don't want to put so many barriers up to prevent the problem that it also yields a system that isn't user friendly to the researchers.

Mrs. BYRON. With the small number of technical managers that you have—and your number is 73. Does giving them that added responsibility shorten their capabilities in what the main mission is? Is it taking them away from their basic research which you think they should be doing?

Dr. COLLADAY. Regarding the fighting of these kind of penetrations, no, I don't think so. We have nationally/internationally famous people working on network technology, and security is just part of their research. I don't think it's a diversion too much. It may be a little there in November—they were putting up there for a time on it. But we kind of worked it into the main——

Mrs. BYRON. It's a challenge that they enjoy?

Dr. COLLADAY. They are challenged by it, and I think they have responded well.

Mrs. BYRON. I guess the thing that has come through again and again in this series of hearings is the shortfall that we have in numbers of qualified, capable, talented individuals to fill the slots that are out there. It concerns me where we're going in the long term because we have got to address it really down at the elementary and junior high school level to make sure that in the next decade those numbers of technically qualified people are going to be there.

Thank you, Mr. Chairman.

Mr. McCURDY. I thank the gentlelady. She is absolutely correct and we all applaud her for taking on that initiative and keeping an eye on it.

The gentleman from Georgia.

Mr. DARDEN. Thank you, Mr. Chairman.

Dr. Colladay, thank you for being here today. I certainly agree also with the very valid and timely points that have been made by here today. I have very little to add to the discussion that has been ongoing.

I did want to just basically mention for a few moments the Pilot's Associate program which you outline on page 16 of your statement. I have had a chance to see somewhat limited demonstrations and was very impressed with the capabilities of this program.

My only question about the Pilot's Associate program is how is the progress coming along, and do you anticipate funding, or have you requested funding for it this year, and are you pleased with the progress so far in the program?

Dr. COLLADAY. I am pleased with the progress, Congressman Darden. I think it is focused on the right deliverables now. By that I mean I think we can have a demonstration that is going to put that technology in a position to be incorporated into advanced aircraft—maybe ATF. It is the ATF scenario that we are using to guide the demonstration. That doesn't mean it's required for that aircraft but certainly if it was available—and that's what we're trying to do—it would be a very large benefit to the avionics system of that vehicle; but also in terms of upgrading the avionics on other aircraft—fighter aircraft—it's going to offer tremendous possibilities.

We have got a long way to go. It's not what you've seen I think in the demonstration at Lockheed-Georgia which is something that functionally operates with all of the variables that we hope to be able to put in the cockpit. What we haven't been able to do yet is to operate that with real avionics hardware and in real time. That's the principal focus of the new prototype program. We will have demonstrated by the end of fiscal year 1989 the full functional capability of the system. In 2 years, with the additional resources that we have in the budget for the prototype, we will transition that using software, using avionics flight-type hardware would demonstrate that functional capability in real time. That should provide the program manager in a SPO office the confidence of incorporating the technology into a new system.

Mr. DARDEN. I'm delighted to see that you have recognized the age-old problem we have of designing a machine which is far beyond the capability of the people who run it, then we've got to go back and lose all this time coming out with a program such as the Pilot's Associate program to integrate into the machine we built.

I think it's a matter of record, our acting chairman here has been one of our leading proponents of DARPA and I think has been, I won't say the father of DARPA , but certainly a very strong supporter, and we always follow his lead when it comes to trying to do something, at least in this committee, about improving on the budget that is submitted by the DOD historically. I assume that he

will continue his advocacy and I assume we will all continue to follow behind him to that end.

Thank you, Mr. Chairman.

Mr. MCCURDY. I thank the gentleman from Georgia.

To follow up on the point that the gentleman raised, wearing your former hat if you would, we used to raise those real issues of human factors and human factors research, and we had a very interesting hearing in this subcommittee toward the end of the last session regarding the low level of research effort in human factors within the Pentagon. To me it appears to be a major issue. If it's an issue in the aeronautics budget of NASA and the cockpits of commercial airliners today, it's an issue in the control room of an AEGIS cruiser, it's an issue in the cockpit of the next generation fighter, it's an issue in the next generation of armored vehicles—you can find it everywhere.

Does DARPA have any efforts going on in human factors research? If not, who does?

Dr. COLLADAY. Not specifically, Mr. McCurdy. We entrain an awful lot of human factors technology in programs like Pilot's Associate because of the display and human machine interfaces, such a large part of that high threat environment; you not only have to present information, you have to present it in the form that the pilot can assimilate.

The service is really analogous to the NASA program do human factors in a physiological sense, it is not done in DARPA. I don't know that DARPA has, over the years, ever had a program in human factors. I would have to turn to Craig——

Mr. MCCURDY. Are we relying totally on the contractor and the expertise of the contractor in marketing his product to handle human factors, or should this not be one of those criteria that any program manager should be trained in or informed of when they are developing requirements for a particular system?

Dr. COLLADAY. There's an interaction in that program with the NASA human factors effort, and as well with the Air Force, because of their involvement in the program. Our program manager on the effort is not a human factors specialist, however. We are not relying exclusively on the contractors without other expertise in the Government in human factors.

Mr. MCCURDY. The problem is we don't know where that expertise is. The witnesses that testified here last year said, yes, there is some moneys—there was some in a Navy program I recall, but not a great deal. It's not exactly high level effort but it becomes a high level effort when you read about incidences like the *Vincennes* where people in combat situations, are under a great deal of pressure, and that's when we start to focus on it. Then it's too darn late.

We need to be incorporating that at some stage. I'm trying to decide where within this budget, that we could at least dictate a study to evaluate the questions of human factors research and implementation of human factors issues in the procurement cycle and R&D cycle.

Dr. COLLADAY. That's right.

Mr. MCCURDY. Does staff have any questions, any follow-ups by the Members?

Mr. Hahn.

Mr. HAHN. Thank you, Mr. Chairman.

Last year the Congress added close to $500 million to the DARPA budget, and that's essentially a reallocation of resources from within the Defense budget.

What's the relationship with the services?

I must admit, I asked that question in the context of we set out here probably 140, and possibly $190 million that might be added to—or reallocated—to the DARPA budget. That has an impact, because your customers are the services.

Dr. COLLADAY. It does have an impact. We are also focusing on technology that the services find of value. Perhaps it's easier, in some respects, for DARPA to move out on some high-risk technology, and we do get support from the services. They also recognize that it comes out of their hide, so that puts us in a conflict with the services. It's no more of a conflict than that which already exists where our independence sometimes puts us in a situation with the services where there's a built-in conflict, but we work that.

I think probably the best case in point is with the Navy right now where I think there's no question that DARPA's budget growth in naval technology is the greatest of any part of the DARPA program; and we have a pretty good working relationship with the Navy. We maintain our independence. But they look at the value of DARPA involvement and they recognize the importance. They smart over the fact that that money has probably come out of their budget and that causes some problems.

Mr. HAHN. The testimony to this point has been with respect to the advanced submarine technology program—zeroing in on that particular program—that it was part of the DARPA's original request for budget allocation this year. Is it then fair from your media testimony to extend that the Navy also supports that program, as you understand the Navy's position?

Dr. COLLADAY. Yes, sir, they do.

Mr. HAHN. This is a question for Dr. Fields. With respect to high definition TV, you and I, quite bluntly, had a conversation sometime ago regarding this, and I think the record to be complete should include your perceptions regarding what is needed in addition to money for high definition TV.

Dr. FIELDS The activity we're doing is aimed at the technology. The technology is not adequate. That's why we've been working with the Department of Commerce and the FCC, and Customs and other places, so that they could deal with the parts of the puzzle that really is under their purview.

The things that are being discussed are things like the following: R&D tax credits, better enforcement of anti-dumping regulations, better enforcement of Customs regulations at the borders, and just a variety of other items like that. The FCC is working with us on the transmission standard issue because a good choice of that will make all the difference in the world. So all those things are going on in parallel.

But since we're the place that seems to have the experience in technology development, naturally that's the place that this work is getting done.

I would like to just add that, Mr. Chairman, when you asked earlier about the activity, I answered in the context of your question, namely, with respect to the commercial competition—realize that in terms of command and control, intelligence, training systems, and so on, all those drive this activity independent of the commercial competition. We've been in the area for quite a long time, long before HDTV became a chic subject.

Mr. HAHN. Thank you.

Finally, Dr. Colladay, in the past, the Director of DARPA has been an Assistant Secretary of Defense.

Do you carry the title of Assistant Secretary of Defense?

Dr. COLLADAY. No, sir, I don't.

Mr. HAHN. Has it had an impact on your tenure at DARPA?

Dr. COLLADAY. That's hard for me to compare, because I've never had it.

Mr. HAHN. Would you like to have it?

Dr. COLLADAY. Let's not make it a personal thing. I think there's some advantage in being involved in the key decisions where the price of entry is the Assistant Secretary level—a dual-hatted function over the last two Directors at least, and that currently is not the case.

Mr. HAHN. Thank you.

Thank you, Mr. Chairman.

Mr. MCCURDY. Mr. Bayer.

Mr. BAYER. Dr. Colladay, in 1984, DARPA transferred a large portion of its technology base to SDI. I think in the last 2 or 3 years, SDI has been less than faithful to several areas—gallium arsenide circuits, some of the shortwave length laser work.

Are we at a point now with SDI putting emphasis on more deployment and less on technology that we ought to think about transferring some of that back to the DARPA budget? I understand you do have budget constraints, but could you address some of these key technologies that are not receiving the level of effort that you anticipated when SDI took those over?

Dr. COLLADAY. Mr. Bayer, there is a problem there. If you go back the timeframe of 1984 and look at the resources that went jointly into technology that SDIO supported and DARPA supported and money that came therefore to DARPA, over those years it's a monotonic decreasing function that started at something like $230 million of SDI resources that came to DARPA to continue some of the things that we're both interested in; to this year, it's down to $28 million, I think.

That, I read, is less and less emphasis on the tech base, which we were jointly supporting. It makes it hard to do long-term multiyear programs when we can't count and depend on the resources and the stability of the funding. That's just a fact of life we've had to recognize and try and work around, but we do see it as a problem.

Mr. BAYER. Thank you, Mr. Chairman.

Mr. MCCURDY. Gentlemen, thank you again for your testimony today. We will be looking forward to working with you again in the future.

The subcommittee will meet at 9:30 tomorrow morning on Special Access Programs.

Dr. COLLADAY. Thank you.

Mr. MCCURDY. The subcommittee is adjourned.

[Whereupon, the subcommittee recessed at 3:50 p.m., to reconvene at 9:30 a.m., Wednesday, March 1, 1989.]

# NAVY AND MARINE CORPS RDT&E FISCAL YEAR 1990 BUDGET REQUEST

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Thursday, March 2, 1989.*

The subcommittee met, pursuant to call, at 1:30 p.m., in room 2337, Rayburn House Office Building, Hon. Dave McCurdy presiding.

## STATEMENT OF HON. DAVE McCURDY, A REPRESENTATIVE FROM OKLAHOMA

Mr. MCCURDY. The subcommittee will come to order.

The chairman, Mr. Dellums, has been fighting the flu now for a couple of days and, unfortunately, is not able to be here this afternoon and I have been asked to Chair.

PREPARED STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

The subcommittee will come to order.

The witnesses today are from the Department of the Navy. They are Mr. Tom Faught, Jr., Assistant Secretary for Research, Engineering and Systems; Vice Adm. Paul McCarthy, Director, Research and Development Requirement, Test and Evaluation; and Maj. Gen. Ray Franklin, Deputy Chief of Staff for Research, Development and Studies, USMC.

In keeping with the format established earlier in these hearings, the Department of the Navy will testify as to their long range R&D plans and will then proceed into discussions regarding specific programs. Unfortunately due to House business, we were not able to meet this morning, and, therefore, the Department of the Navy testimony will have to be taken during this afternoon's session.

The budget which is before the Congress currently is the Reagan budget, which has set out $10.184 billion for the Department of the Navy Research, Development, Test, and Evaluation for 1990. We will not have to review that entire budget in view of the fact that we are holding special hearings on certain topics directly associated with this Navy budget. Particularly, I note the hearing we had yesterday on certain special access programs, the hearings we will hold later in the month on advanced submarine technology and underwater warfare, and finally a hearing on anti-satellite systems.

I understand Mr. Faught, that you have an oral presentation which you would like to make during the session regarding the Navy's long term planning. I propose that we begin with your statement and that as we proceed into the questioning from the members we can get into specific programs.

Mr. MCCURDY. The witnesses today are from the Department of Navy. They are Mr. Tom Faught, Jr., Assistant Secretary for Research, Engineering and Systems; Vice Adm. Paul McCarthy, Director of Research and Development Requirements, Test and Evaluation, and Maj. Gen. Ray Franklin, Commanding General, Marine Corps Research, Development and Acquisition Command.

In keeping with the format established in previous hearings, the Department of Navy will testify on their long-range R&D plans and then proceed into discussions regarding specific programs.

Unfortunately, due to House business, we were not able to meet this morning and, therefore, the Department of Navy testimony will have to be taken during this afternoon's session.

The budget currently before the Congress is the Reagan budget, which has set out $10.184 billion for the Department of Navy Research, Development, Test and Evaluation for 1990.

We will not have to review that entire budget in view of the fact that we are holding special hearings on certain topics directly associated with this Navy budget. Particularly I note the hearing we had yesterday on certain special access programs and the hearings we will hold later in the month on advanced submarine technology and underwater warfare as well as a hearing on anti-satellite systems.

I understand, Mr. Secretary, that you have an oral presentation which you would like to make during the session regarding the Navy's long-term planning. I propose that we begin with your statement and when we proceed into questioning from the Members we can then get into specific programs.

Before I begin, I would like to yield to the subcommittee's Ranking Member, Mr. William Dickinson. Mr. Dickinson is not here at the present time, so we will just admit his statement into the record.

PREPARED STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Welcome gentlemen.

This is already shaping up to be a difficult year for the defense budget process, both in the Pentagon and up here on Capitol Hill. Although we are now all working off the Reagan budget, we are waiting for President Bush's amended, zero real growth request. It is my understanding that as part of the budget drills now being conducted by the services that the Navy is having to cut more than $2 billion out of their initial request. I would be interested in knowing how much of this cut will be taken out of the Navy R&D budget and, in particular, whether or not the $94 million in ASAT funding will survive. As you know, I have been a strong proponent of Navy support for ASAT since it is the Navy who would benefit most from the system operationally.

However, it is my understanding that the Defense Acquisition Board met earlier this year and concluded that the program should be funded and managed out of the Department of Army. ASAT is already an extremely political issue and if, as I fear, this new program is plagued by service in-fighting, the political problem will be exacerbated. Despite the fact that this subcommittee will have a dedicated hearing on ASAT in the future, I hope that you can be as forthcoming as possible today on the political and substantive ASAT issues.

The Navy's candor will assist this subcommittee's timely and hopefully sensible mark-up of the fiscal year 1990 budget.

While ASAT is an important issue, there are a number of other Navy programs of interest to this Member, as well as my colleagues. So, thank you gentlemen for appearing here today and we look forward to your testimony.

Thank you, Mr. Chairman.

Mr. MCCURDY. Mr. Secretary, please proceed.

As I indicated earlier, I have to go Chair my own subcommittee in the Intelligence Committee at 2 o'clock so I'm going to have to leave a little earlier but don't let that interrupt you once you've started. Please proceed as you wish.

**STATEMENT OF THOMAS F. FAUGHT, JR., ASSISTANT SECRETARY OF THE NAVY (RESEARCH, ENGINEERING AND SYSTEMS) ACCOMPANIED BY DR. ED TUNSTALL, DIRECTOR, NAVY LABORATORIES, AND BILL SCHAEFER, DEPUTY ASSISTANT SECRETARY OF THE NAVY (AIR WARFARE)**

Mr. FAUGHT. Thank you, Chairman McCurdy. We are going to, as you suggested, truncate the planning, direction and policy portion of our presentation today, but just to give you some idea of how we intend to proceed, we do have two parts to our hearing, today.

First is our plans and direction from policy and then, second, we want to address specific budget issues as well as the attendant programs.

Before beginning I'd like to quickly introduce the people who are with me: Vice Adm. Paul McCarthy, who is the Director of R&D Requirements, Test and Evaluation for the Navy. One of the things that we were asked to give today was an idea of why we're going in the direction we are; and both Vice Admiral McCarthy and Maj. Gen. Ray Franklin will give a prospective as to where the Navy and the Marine Corps will be mission-wise in the 2030–2040 period.

Richard Rumpf is my principal Deputy Assistant Secretary. Rear Adm. John "Smoke" Wilson Chief of Naval Research is also here. We have several associates here to respond to specific questions you might have on the programs.

I would like to briefly review the things that we set out to do this year and some of our accomplishments, I wish to emphasize that these accomplishments really have been a result of a great deal of effort on the part of Navy and Marine Corps officers and OSD people as well as our own civilian crew in the Navy. Among these things we have developed, and we're putting in proposal form now, is a new Navy R&D organization, which will greatly centralize the various functions that have been providing R&D services Navy-wide to date.

We have given significant emphasis to organizing by following Navy mission areas. We have, for example, in anti-submarine warfare brought together R&D for the various platforms, weapons and sensors in an integrated battle management group.

We have also put together for the first time a 15-year R&D plan. That plan is now being completed and will be provided to you in the form of a report, and I'd like to make that for the record upon completion of that plan.

[The report was not received at time of printing.]

We have started to initiate changes in our vendor selection process. As I mentioned in my prepared statement to you, we are indebted in part to the Air Force for some of the criteria they have been using recently and we intend to adopt some of those criteria in our own vendor selection process.

We have commenced meetings with senior congressional professional staff in the Pentagon to keep them current with what we're doing and why we're doing it. We have had four meetings to date and we're looking forward to continuing those in the future.

We have directed a development plan in Navy for the manufacturing and process technology development and, of course, as you

know, the initial project involved in that is the RAMP program in South Carolina.

We have initiated what I'd like to call a "selling campaign" in Navy, to OSD and the Congress to extend the successful "China Lake" personnel management experiment. This experiment began some 10 years ago, to give a greater incentive to our technical and scientific people. This program is really quite vital to us and I'd like to address that later on.

We have completed the first phase of a two-phase program to significantly reduce the time it required to get a new major system on the deck or in the field. We completed the first phase in January and we presented that to the Secretary of the Navy, and to OSD as well. We look forward to completing this effort in about 6 months. At that time we should be able to specify what has to be done to reduce that total time to IOC from a couple of decades down to somewhere around 12 years.

We have also commenced a public relations awareness campaign which we hope will attract talented people to Navy R&D. As all of you are aware, after World War II, Navy R&D was preeminent in the field of research, not only in this country but around the world. This activity is one step to get Navy research back to what it once was. We need talented people and we need many of them in the future. We're trying to interest those young people in Navy R&D activities and also to the national engineering and scientific community as well.

We have initiated a Navy international cooperative R&D plan for the long-term. R&D international cooperation is vital to us. It is vital to our ability to keep in step with technologies being developed in other parts of the world. That program will be also part of the 15-year plan I alluded to earlier.

We have completed a first round of nationwide meetings with leading industrial leaders and university officials. We tell them where Navy is going in terms that will justify in their minds that we have the confidence of our direction so that they will support with their own money Navy related R&D efforts.

I think in respect to the time, I'd like to stop here and have Admiral McCarthy provide you with an idea of where the long-term strategy of the Navy R&D is leading and that will be followed by General Franklin. That will give you some perspective of how we're going, what we're setting out to do, to what kind of platforms and systems we're developing, and insights of supporting technologies required for those systems.

Paul.

## Prepared Statement of Thomas F. Faught, Jr.

Good morning Mr. Chairman, and distinguished members of the Subcommittee. A year has passed since I appeared before this Subcommittee and much has happened. I appreciate this opportunity to appear before you again and report on the progress achieved in Navy Research, Development, Test and Evaluation (RDT&E).

Today I will focus my discussion with you on specific issues. In particular I will address the course of action that we have taken to improve the overall Navy RDT&E function and process. I will also present information supporting our budget request and the status of a number of our important programs.

However, before doing this, I would like to introduce my colleagues who are joining me today.

With me are Mr. Richard L. Rumpf, my Principal Deputy; Vice Admiral Paul F. McCarthy, the Director, Research and Development Requirements, Test and Evaluation, and Major General Ray "M". Franklin, the Commanding General, Marine Corps Research, Development and Acquisition Command. Additionally, there are other members of my staff here to answer questions that may arise today.

I assumed the responsibility of ASN(R,E&S) in a complex and interesting period. Budget constraints and programmatic pressures were becoming greater. A long-sitting administration was entering its final year in office. Adding to the dynamics of the times, soon after my confirmation, an investigation centering on the Pentagon acquisition probe came into the public view. The uncertainty resulting from these events and their impact on morale was tremendous. Truly, this has been a challenging time!

Coming from a background in industry, I found that Navy's research and development program had many strengths and several weaknesses. Principal among its strengths were the quality, commitment and dedication of its scientific and technical people, the increasing professionalism of its program management personnel, the sound tradition and pride of Navy R&D and of the "Navy Labs", and the mutual respect and seriousness of purpose which characterizes top Navy military officers and their organization.

Weaknesses also existed which required attention and correction if Navy R&D was to be effective and to achieve its potential; particularly in an environment which required that funds be spent more judiciously. Principal among these weaknesses were the following:

- The program development process to deliver systems to the Fleet was cumbersome, confusing and extremely time consuming--it took decades, not years for IOC!

- Certain Navy R&D functions, responsibilities and accountabilities were fragmented and scattered.

- Communications with the other Services, the OSD and the Congress were inconsistent, incomplete and, at best, sporadic.

- R&D efforts were imbalanced toward new systems, new platforms and new weapons with inadequate attention given to improving, modernizing and upgrading proven, existing assets.

- Financial and cost reports were geared far more toward answering questions of controllers and outside agencies than toward providing data to better manage the job.

- Navy R&D lacked a long-term plan without which there was poor justification for funding stability and strategic support.

- The Tech Base, extremely vital to Navy's future strength, was eroding rapidly.

- Navy labs and research centers increasingly were involved in engineering relating to today's problems rather than in development to meet tomorrow's challenges.

- Program managers were constrained and restricted from applying their sound and experienced judgment because of straight jacket policies and procedures, and the resulting fear of possible failure.

- Research and development focus was on "Platform" (ships, submarines, aircraft, guns, etc.) rather than on Missions" or "Battle Management" (ASW, Anti-Air, Strike, etc.). Consequently cross platform systems such as C3I and electronic warfare, which are essential in warfighting success, were receiving inadequate sponsorship and support.

- International cooperative R&D efforts were sporadic, inconsistent and lacked integrity, clear direction or strategic support. There was no plan to achieve ill-defined goals.

- Successful laboratory personnel and management enhancement programs, begun a decade ago as a "2-year experiment", remained as prototypes: programs vital to the Navy's ability to compete with industry in attracting and retaining skilled, innovative scientific and technical talent.

- Laboratory facilities and equipment, long a hallmark of Navy's world-wide scientific preeminence were obsolete, inefficient, decaying and rapidly falling behind those required to successfully pursue today's high-tech developments and to test such results. For example, over 73% of Navy's permanent buildings used for R&D were constructed well before 1960, and the planned rate of renovation or replacement indicate a continuing worsening situation.

- An adversarial relationship had developed between Navy and industry which adversely affected industry's interest in the Navy market; a relationship evolving from mistrust, cumbersome and ill-conceived procedures, suspicions, inexperience, ignorance and a lack of communications.

- A contracting/acquisition environment based more on legally-oriented, risk-adverse bureaucratic policies and procedures than on goals of achieving products of the highest quality, dependability and most attractive life cycle cost. Inflexible policies, instructions, directives, orders, and procedures coupled frequently with unrealistic, unilaterally-imposed scheduling goals and herky-jerky funding practices were leading to high direct costs, expensive schedule delays, cost growths, quality problems and lack of accountability.

Other problems affecting Navy R&D obviously required attention. However, some of these, such as the dearth of qualified, well motivated American scientific and technical university graduates and the eroding U.S. industrial base, are of national importance and require solutions far beyond the capability of the Navy. Neither do I mean to imply that those weaknesses outlined above are exclusively those of Navy nor that they have not been identified earlier by others. Indeed, several were addressed early in this decade by the then Deputy Secretary of Defense, Frank Carlucci. Such problems also have been the subject of the Packard Commission Report and the Goldwater-Nichols legislation. Some of these weaknesses were alluded to much earlier in previous Administrations.

However, regardless of how long these problems have been around, indeed because of the increasingly adverse affect of their long lives, it is time that they be given Navy attention and be "run to ground".

During this past year we in Navy R&D, with the support of the Navy Secretariat, top uniformed Navy and Marine Corps officers and, as appropriate, OSD officials, have initiated several actions aimed at eliminating these weaknesses. These actions have included the following:

- Developed and proposed a new Navy R&D organization structure and function description, centralizing and streamlining Navy-wide RDT&E responsibilities within a single center in the Secretariat, thus providing improved, simplified civilian oversight and control, accountability and communications.

- Significant emphasis has been given in this new structure organizing by warfare mission or battle management area rather than by platform type. In particular, additional emphasis has been given to the ASW area; the first such warfare mission oriented approach that the Navy has taken.

- Drafted a long-term R&D plan for Navy, setting forth technical development and funding requirements for the next 15 years (20 years for facilities and equipment). This plan will provide for a Tech Base achieving minimum annual funding of $1 billion as soon as practicable, and an overall annual R&D funding growth of a minimum of 2.8%, excluding facilities and equipment.

- Initiated changes in the Navy vendor selection process for R&D work which incorporates criteria established by the Air Force, giving value to a vendor's past performance regarding quality, schedule performance, dependability and innovative contributions as well as attractive (not, necessarily, the lowest) price.

- Commenced periodic meetings with senior Congressional professional staff members to assure that they are informed as to "Where We Are", and "Where We're Going" regarding major programs, development plans and project problems. A principal goal which we have regarding these meetings is to focus attention on the need for stable program funding.

- Directed the development of a plan to refocus manufacturing/processing technology development activities in Navy R&D similar to that established by the Air Force and industry; the initial effort being to enhance our RAMP Program.

- Initiated a "selling campaign" in Navy, OSD and the Congress to extend the successful "2-year" personnel management experiment to all other Navy laboratories and research centers.

- Completed the first phase of a two-phase activity aimed at reducing the time required by Navy to get a new, major system "on the deck" or "in the field" from decades to about 12 years, maximum. This is a Navy-wide effort with the contribution and support of "all hands" (Phase I results were presented to OSD).

- Identified that future Navy R&D will be a composite of funds provided by the Navy and OSD, with a significant amount coming from industry IR&D and the international community.

- Commenced a public awareness/relations program with the objective of encouraging talented, highly motivated young people to become scientists/engineers in the Navy R&D community. This program includes bylined articles in leading publications, conferences and speeches, both in the U.S. and abroad, broadened Navy-industry personnel exchange programs and their outreach efforts.

- Initiated a Navy international cooperative R&D Plan for the long-term, the first step of which is to identify with our allies the technological "edges" or advantage which each country possesses as well as their security limits. We also are defining the present, general international cooperation goals (i.e., 10% of Navy's effort by 1994; 25% by 2004) in more precise, technologically-focused terms.

- Completed the first round of nation-wide meetings with industry leaders and university officials with the goal of encouraging their unilateral participation in Navy-oriented research and development activities. Ten meetings have been conducted with about 180 companies and 80 universities to provide information on the Navy's strategic direction, our technology interests, long-term business opportunities with Navy, and changes we are considering in our contracting/ business practices to make Navy a more interesting, attractive market.

- Supported the successful continuation of the Navy Industrial Fund (NIF) program concerning the Navy laboratories and research centers, thus providing modest means to help restore facilities to their post-World War II excellence.

- Established guidelines for Navy R&D which should assure that a significant portion of future Navy R&D expenditures are used to improve and upgrade existing systems, platforms and weapons, including such steps as androgynous designs, modularity, etc., to reduce the variety of assets. The initial guideline is 16% of the total, annual Navy R&D budget by 1992.

- Commenced periodic meetings with the Assistant Secretaries of the Air Force and Army who are responsible for R&D to better coordinate inter-service development programs and efforts, and to obtain ideas as to how Navy can better do its job.

- Brought top Navy and Marine Corps officers and officials into the R&D planning and decision process to increase their understanding, obtain their ideas and to strengthen their sponsorship and support on key issues.

- Initiated changes in the R&D acquisition process to make it more efficient and less costly, including steps toward the elimination of the Best and Final Offers (BAFOs), protection of proprietary property rights and a better understanding--a more open approach--to understanding Navy's requirements and specifications; all of which should result in greater innovative contributions by industry. These changes should reduce vendor costs, translating formerly unproductive resources into IR&D applications.

You will notice that, while several steps are underway to correct problems, few of these actions yet are completed. However, they are sufficiently well along and an adequate support base of people is in place to ensure that these actions can be completed in the foreseeable future.

The Realities of a Constrained Budget

The resources provided in the past for Navy RDT&E have been well spent. The Navy of the near future will center on platforms that utilize technology currently under development including:

- AEGIS Cruisers and ARLEIGH BURKE Destroyers with SPY 1B/D radars
- SSN-21 submarines with advanced quieting
- A-12 aircraft with reduced signatures
- selected modernization of existing forces

The challenge for the future is preparing for the Navy of the 21st century by:

- ensuring that we continue the lead in key technologies
- streamlining the bureaucratic process to introduce new technology to the fleet more quickly
- working effectively and efficiently within a constrained budget environment

However, we must still face the realities of a stringent budget environment which started four years ago. As such, a number of programs have been cancelled or deferred for FY 1990 including:

- Advanced Sea Mine
- Integrated Communication System/Shipboard Communication Area Network (ICS SCAN)
- A-6 Remanufacturing (A-6G)
- Vertical Launch ASW Rocket
- Marine Corps Hyper-Velocity Missile

Lastly, there are a small number of programs that will start, including:

- Anti-Satellite Program (ASAT)
- EA-6B Aircraft Improvement Program
- Advanced Interdiction Weapons System
- Advanced Warhead Development for Mk-50 Torpedo

Our budget request for FY 1990 is $10,184 million and for FY 1991 it is $9,636 million. As shown in Figure 1, funds are spent in a number of battle management and support areas. In FY 1990/1991 a majority of funds, about 24%, are devoted to Anti-Submarine Warfare programs. Our Air/Anti-Air Warfare Programs utilize about 18% of our resources while our Strike/Surface initiatives use about 23%. We devote about 7% of the funds for our Strategic programs and 6% for Expeditionary Force programs. Lastly, about 12% is spent on cross mission areas and classified efforts. Looking to the future, by the year 2005 while R&D funding increases in all areas, Cross Mission and Strategic realize considerably greater increases in funding; largely at the expense of the Surface/Strike area.

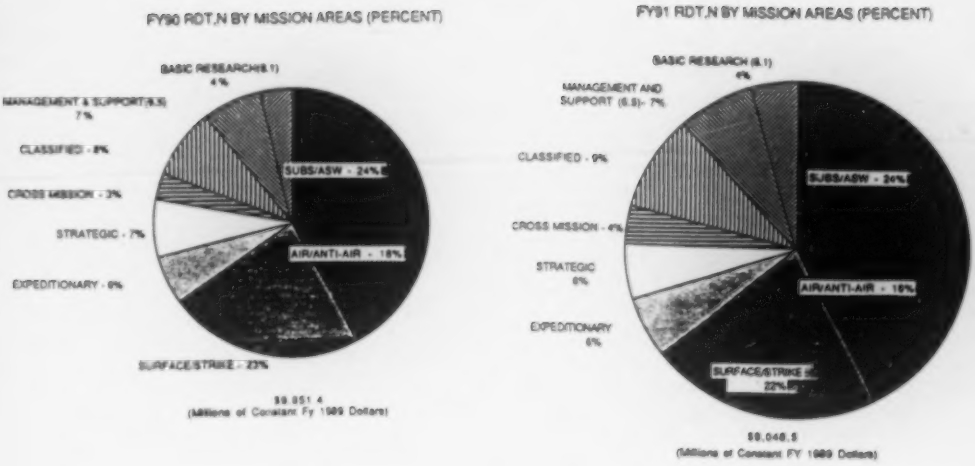



Figure 1

Looking to the future, based on our preliminary funding estimates by mission area, the distribution in the year 2005 (Figure 2), would appear as follows:

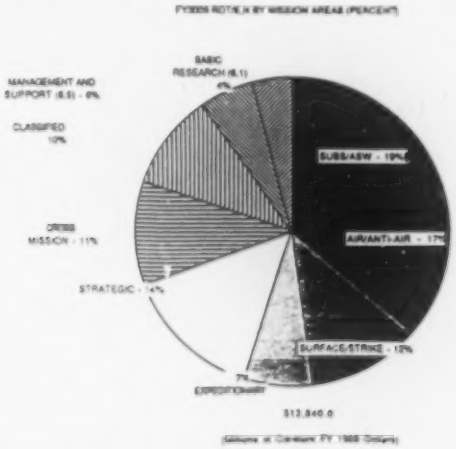



Figure 2

Note the shift in emphasis toward strategic and cross mission areas.

In addition to the trends in our future 15 year R&D operating plan, we look for significant improvement in our facilities and equipment for our laboratories and test assets.

CHALLENGE AND ACTIONS

Our challenge remains - we must maintain the high capabilities of today's Fleet while looking well over the horizon toward the development of our future Fleet. This requires innovative management of constrained resources. We must continue the balance among requirements, resources and programs. The concept of being able to "turn on" and "turn off" technology to meet a new threat must be considered carefully. Funding stability is vital. Avoiding variable program funding prevents false starts, delays, terminations and costly stretch-outs. The Navy R&D Program for FY 1990/1991 carefully considers priorities and supports efforts vital to the efficient execution of the naval mission:

- A revitalized Tech Base program. The future Fleet will develop around ideas and inventions molded from our laboratory, university and industry infrastructure.

- ASW efforts including weapons systems, sensors, platforms, and the fusion of warfare information. Upgrades in our SSN-688 class attack submarines, significant progress in lead ship procurement of the more capable SSN-21 SEAWOLF class, and development of even more advanced submarine technology.

- STRIKE systems with across the board impacts from the design of the next generation carrier capable medium--attack bomber (A-12) to the success of the PIONEER RPV System that supports the Fleet. These are in addition to Standard Missile - 2 Block IV program, AEGIS weapon systems upgrades and technology efforts such as integrated electric drive for ships.

- The successful TRIDENT II D-5 strategic missile system and cruise missiles such as the TOMAHAWK.

- Improved C3I/EW systems are the "glue" that enables us to use warfare information in making appropriate decisions concerning force movements and directing weapons to targets or preventing enemy action against our platforms. This is of particular importance to the naval forces, remembering that the oceans comprise three-fourths of the earth's surface.

- U.S. Marine Corps, Expeditionary Force programs that provide more effective weapons for a lighter, more mobile force.

- International armaments cooperation efforts that (a) reduce the cost of developing weapons systems through sharing of R&D cost burden, (b) to ensure that common requirements are met as weapon costs increase, (c) maintain Allied industrial base technologic/economic equivalency, and (d) compensate for decreases in Foreign Military Sales.

- Interservice development activities which result in lower initial costs and subsequent logistic support expenses.

Lastly, the strength of Navy R&D lies in the excellence of our technical people. The scientists and engineers working at our laboratories and centers are at a significant compensation disadvantage compared to their industrial and university counterparts. Our managers need the flexibility to identify and rapidly reward their most talented and productive people before their needs drive them to other activities. The action taken by the Navy with the help of Congress to reduce this problem via the "China Lake Experimental Personnel System" has been an excellent first step in providing appropriate assistance. However, this has been a band-aid approach. Even though the concept has been expanded in geographic scope and extended from two years to ten years it is believed that even more needs to be done. Clearly, we must work together to make this experiment an established policy for all service laboratories.

CONCLUSION

In the FY 1990/1991 timeframe and beyond we see increased competition for scarce resources. We have noted the specific actions that the Navy has taken to focus on planning (both short and long range) that will help us to build a superior and effective future Fleet.

However, our work is not done. It is essential that the strong partnership that has been established between the Navy and Congress be maintained. We in Navy RDT&E will work continuously to justify your support which is essential to the success of future Navy and National goals.

**STATEMENT OF VICE ADM. PAUL F. McCARTHY, DIRECTOR, RESEARCH AND DEVELOPMENT REQUIREMENTS, TEST AND EVALUATION, DEPARTMENT OF NAVY**

Admiral McCARTHY. Mr. Chairman and members of the committee, thank you very much.

Last week, Rear Admiral Brooks, the Director of Navy Intelligence, appeared before the House Seapower Subcommittee on what we, the U.S. Navy, perceived the threat to be. There are a number of areas concerning the Soviets that worry us, beginning with the continuing upgrade of their submarine program. With such boats as the *Victor III,* the *Akula*, the *Alfa* and the *Sierra*, they have shown no remission to shy away from advanced submarines or advanced submarine technology.

The Soviets are also continuing their aggressive efforts in missiles with the SSN-21, commonly called the Tomahawkski, and the SSNX-24. In addition, they are improving their posture in space.

Today it appears that the Russians are fielding fewer platforms than in the past years. However, those platforms are an improved product over what we have previously seen—very high tech.

This type of threat assessment, obviously on a much more expanded scale, is one of the foundation blocks that we start our annual planning and programming cycle with, to continually update our perspective. There are also other building blocks such as warfare appraisals and assessments that meld into this cycle.

During the past 2 years, we have conducted two major studies to look at the challenges that we in the Navy face far beyond the 5-year defense plan.

The first of these studies is called Quo Vadis, and this study essentially took a hard look at our current R&D account to see if it would in fact meet the threat now and out through the next decade. It also reviewed the current state of technology to see if we had overlooked any critical innovations. I might add that this look at Navy R&D was done completely outside the Navy to remove any semblance of bias.

Our second major effort was a study called Navy 21, a long-range look at the Navy in the 21st Century out to the year 2030 or 2040, some 50 years hence. The objective of that study was to determine the implications of advancing technology on naval warfare during that time frame and identify new technologies, assess the implications on traditional force structure, determine what the impact would be on our maritime strategy and potential Soviet responses.

This independent study was done under the auspices of the National Science Foundation and included some 180 distinguished members.

Both of these efforts saw no change in the basic roles and missions of the United States Navy, but they did reveal areas that we need to pay greater attention to—areas of space and connectivity, stealth, information systems, submarine and anti-submarine warfare, and longer range precision guidance munitions among others.

There are also a number of key technologies associated with weapons guidance, data processing and fusion, computation and decision aids that were recommended for the required list.

As we develop our long-range plans, we are using both of these studies as a truth check in looking at what we are doing in exploratory and advanced development programs in addition to our technology demonstrations.

But our planning process and research and development is obviously much more dynamic. We try to be responsive to technical changes we currently see in other nations through the foreign weapons evaluation program or at our senior national representative forums.

During the year, it is not uncommon to see a particular piece of intelligence pop up reflecting an important change in how we should be doing business. We have briefed some of the members and staff on a recent event that we could discuss in a closed session.

Throughout the year, we in Navy form ad hoc teams to review warfare areas, such as anti-submarine warfare or strike. These teams, in conjunction with a number of outside experts, burrow into the particular warfare area, pore over the threat, weigh the future, look at areas of susceptibility, review products and recommend priorities.

It is a process which is the cornerstone of our master plans; for instance, the ASW Master Plan.

Let me give you an example of the process in action. It is obvious that the Soviets have discovered the importance of quieting in their submarines. For many years, and still today, we in the United States Navy had been purveyors of the passive acoustic art. We now see selected noises and levels receding or those levels being submerged in the normal noises of the ocean background.

After a number of meetings a few years back, we started looking more to an area that was all but forgotten and that area was active sonar. You will remember it as the familiar ping.

Thanks to the efforts of these teams and the effort of a number of other people, we are now redirecting our ASW acoustic efforts into a more balanced arrangement, to include non-acoustic and active ASW.

There are any number of ancillary efforts associated with submarine and anti-submarine warfare programs that we have put into action. Programs that will quiet torpedoes and make them more stealthy. Fiber optic arrays that will increase sensitivity while easing the installation. Construction of a large cavitation channel in Memphis will improve our understanding of large-scale flow noises and hull and propulsor interactions.

One of the other areas that may give you or the members some concern is the compartmented program. Let me first state that before a program is placed in a compartmented status, it is carefully weighed as to why it should go in that status. A driving factor is our national security and sensitivity. I might also add that we in the Navy have only a few of those programs and they represent less than 2 percent of our total budget.

Some of you may have heard of our electric drive efforts. We have known for sometime that all electric ships offered significant flexibility but, unfortunately, we had not found the key to unlock the Gordian knot. Also, we did not have the incentive of high temperature superconductivity on the horizon.

As you will see in this year's budget request, the Navy has embarked on a deliberate course to establish electric drive as the propulsion for the next class of battle force surface combatants. To do this, we are looking at a number of parallel efforts, involving higher performance gas turbines, shipboard power generation and distribution systems, advanced propulsors and machinery control systems.

There are other complementary efforts ongoing in areas such as superconductivity and directed energy weapons. We believe that these programs, which encompass four different budget lines, are very forward-looking examples of driving technology to a goal.

Mr. Chairman, with you and your committee's support and that of other Members of Congress, we will continue to keep the cutting edge of the fleet honed to a razor's edge.

Thank you.

Mr. MCCURDY. Thank you.

Mr. FAUGHT. I might add to that that when we spoke with Congressman Dellums, he said when the budget smoke clears—I think in April or May—that he would like to have a briefing on the Navy 21 Study, which Paul mentioned, and we certainly are prepared to do that.

Mr. MCCURDY. General, as I indicated, I am going to have to leave and am going to turn the Chair over to Mr. Hertel, but as I said earlier, I hope that in your statement that you cover the current development progress of the V–22 in some detail for the record.

Mr. HERTEL. [presiding] General Franklin.

## STATEMENT OF MAJ. GEN. RAY "M." FRANKLIN, COMMANDING GENERAL, MARINE CORPS, RESEARCH, DEVELOPMENT AND ACQUISITION COMMAND

General FRANKLIN. Mr. Chairman, members of the committee:

The Marine Corps is always happy to come here and give you our view of the future.

I would like to start out with a little bit of history that may set the stage. The Marine Corps is an organization that changes rapidly when we observe the threat changing.

Back in the 1930s, we sent a small group of people through the Pacific Islands. We realized that they were being fortified; and less than 20 Marines went back to Quantico and developed the amphibious warfare doctrine, tactics, and techniques that allowed us to battle our way across the Pacific.

In 1946, a nuclear weapon exploded in the midst of a large array of anchored ships and everyone said, amphibious assault is gone forever. The Marine Corps jumped on a new technology, formed a little outfit called HMX–1 at Quantico and said, the helicopter is the answer to that, and we will spread the ships out and we will come from greater distances at greater speeds. So vertical envelopment was invented by the Marines in about 1947. In Korea, we did our first vertical envelopment using HRS's, hauling four people each, and moved a rifle company in half a day.

In the 1970s, we observed that the threat had crawled into little tin boxes, some of them with thick skins, some with thin skins. But

the implication of that was that these little tin things moved across the battlefield at very high speeds. That meant that the Marine or the soldier who needed close air support didn't need it in an hour or this afternoon, or the next day, he needed it in a matter of minutes, which meant that response time was extremely important.

It also meant, with the advent of more precision weapons, that large airfields may not survive. The Marine Corps stood as the lone service, and with the help of the Congress, brought in a new concept called VSTOL close air support, mainly the AV–8 Harrier.

So we have been on the forefront in innovative thinking. As we look into the 21st century, we see some new challenges. One of the things that greatly concerns us is the enemy's version of Admiral McCarthy's new weapons—the Tomahawkski, the Harpoonski, and the Hellfireski. All of these systems have been adapted by various nations—not all of them large nations—to shoot at shipping from the shore.

Our answer to this is over-the-horizon assault. We firmly believe that in the future we must open the battle space and not bring major combatants into visual range of the shore. We don't want to give the other guy a cheap optical shot. If he's going to target major ships, make him come out and do it the hard way, like we have to do it. But we believe that with a triad of equipment we can pull off an over-the-horizon assault.

One thing is already in the Fleet and proving very successful, and that's the LCAC.

Another item that's just about to enter the Fleet, as soon as we get it off the ground, is the OSPREY, the V–22.

The third part of the over the horizon assault force is an advanced amphibian assault vehicle. Our existing amphibious assault vehicle will be 32 years old when the IOC of our next one is due, which is about 1998. That's the lifetime of four automobiles for the average American. We don't believe that we should keep the old assault vehicle in service any longer. It also is limited in speed. We cannot come from over the horizon with this amphibian tractor.

Over-the-horizon assault allows us to do a number of things. First it keeps the amphibious fleet out of sight of land. Second, it brings the amphibious fleet back under the protective umbrella of the striking carrier force, and it gives us more battle space to see these missiles coming at us and time to do something about them.

It also complicates the other guy's problem. If you look at the mathematics of it, an amphibious task force, 24 hours off the East Coast of the United States in the year 2000, with those three legs of an over-the-horizon amphibious assault, can threaten an area from Boston to Charleston. That gives the fellow sitting on the shore a tremendous problem as to where we're going to be.

It also, since we have opened up the speed range of the vehicles, allows us to do different portions of the amphibious operation at greater separated times. Today we do everything almost simultaneously. It's a very, very demanding process. With V–22 we can start the amphibious assault from 200 miles, and an hour and a half, 2 hours later we can launch the LCAC. Two hours after that we launch the high-speed tractors. With the tremendous speed differential, by the time the Ospreys have made three trips, the LCACs are arriving with their first trip, and the tractors will

arrive shortly thereafter. You have a much more dispersed operation. You will not have to meet the fellow on the beach. It will be a meeting engagement in which he has to figure out where you really went. We see that as the wave of the future—you take care of the standoff weapon problem.

The last area I'd like to mention briefly is the cheap war. We see that as the most likely war of the next century—the regional conflict, the small war. In those wars, mines and booby traps are the big casualty-producers.

In the first 5 years in Vietnam, 70 percent of our casualties were caused by mines and booby traps. We are spending 13 percent of our budget in counter-mine, counter-booby trap technology. I have to admit, there are no real nice breakthroughs hiding out there that we can see. We have taken a brute force approach; we are going to assume they are there and blow them away. But, we are also exploring ways to find them and avoid them.

Those are sort of the views of the world 20 to 30 years out that we see—small wars; precision guided munitions available to everybody; stay away from him, try to find him, and avoid him. When you do meet him, don't meet him on the beach; meet him downtown in his own town.

Thank you, sir.

Mr. HERTEL. Thank you, General Franklin.

I thank you all for your testimony.

Mr. FAUGHT. Excuse me, Mr. Chairman.

Mr. HERTEL. Yes, Mr. Secretary.

Mr. FAUGHT. We have a couple more items here if I may.

Mr. HERTEL. OK.

Mr. FAUGHT. Admiral "Smoke" Wilson is the Chief of Naval Research. The tech base is vital to us and we hope to entertain some discussion of that today. Smoke is responsible, among other things, for our tech base operation. I would like him to make a few remarks about the importance of that area to us.

## STATEMENT OF REAR ADM. JOHN WILSON, CHIEF OF NAVAL RESEARCH

Admiral WILSON. I have passed out some briefing handouts, and if you will, I'd appreciate you following me through the slides.

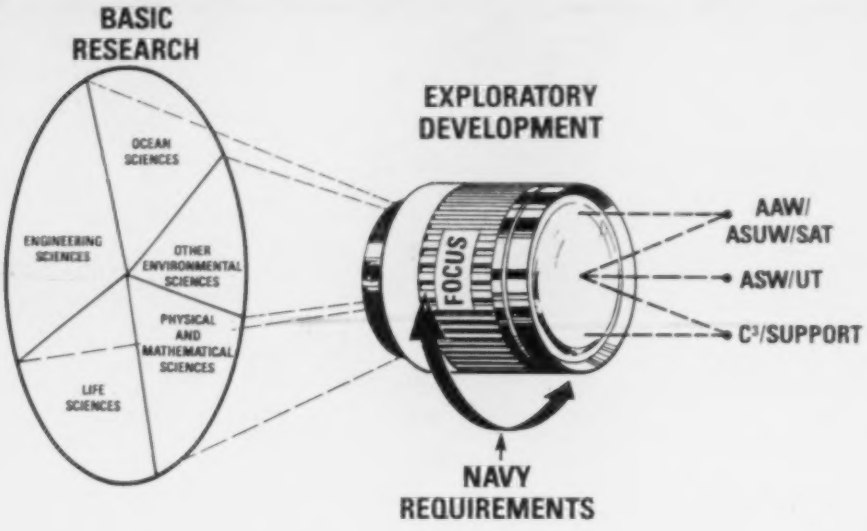
Slide 1.

# OFFICE OF THE CHIEF OF NAVAL RESEARCH

Admiral WILSON. As mentioned, I am the Chief of Naval Research, and I will be outlining for you the Navy's technology base program management for Category 6.1, basic research and Category 6.2, exploratory development.

Almost without exception, the weapon systems to be briefed to you today are a product of extensive Navy research and development efforts of the past and those yet unknown systems of tomorrow will be based on currently funded technology.

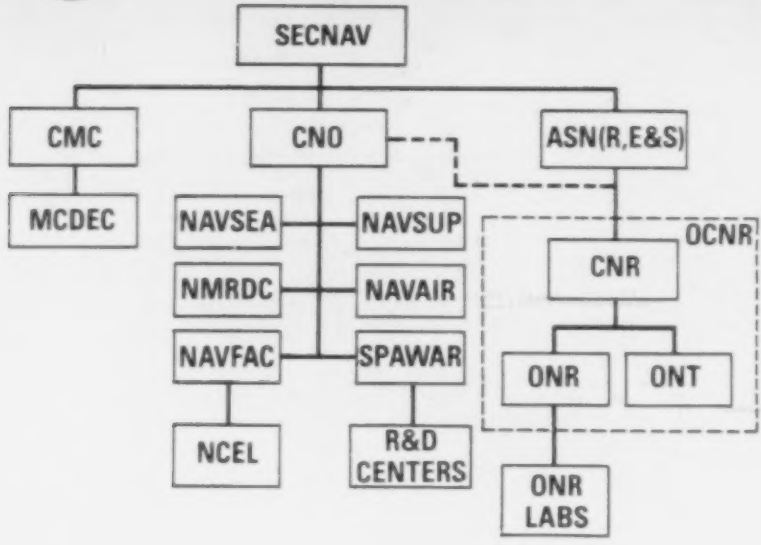
# 6.1/6.2 RELATIONSHIPS




Slide 2. To put these programs in perspective, the basic research is conducted in the scientific discipline to provide us new knowledge, understanding, and capabilities with a potential for application to Navy problems.

The exploratory program then draws on that scientific foundation and focuses this new understanding on naval missions and conceptual application.

## DON ORGANIZATION FOR SCIENCE AND TECHNOLOGY




Slide 3 is a basic wiring diagram that covers our tech base management. It's conducted within the Office of the Chief of Naval Research, is directly responsible to the Navy Secretariat through Mr. Faught.

There are two distinct organizations within the Office of the Chief of Naval Research. The Office of Naval Research is directed by Dr. Fred Saalfeld, a Ph.D. in chemistry, who joined the Government service at the Naval Research Laboratory in 1963.

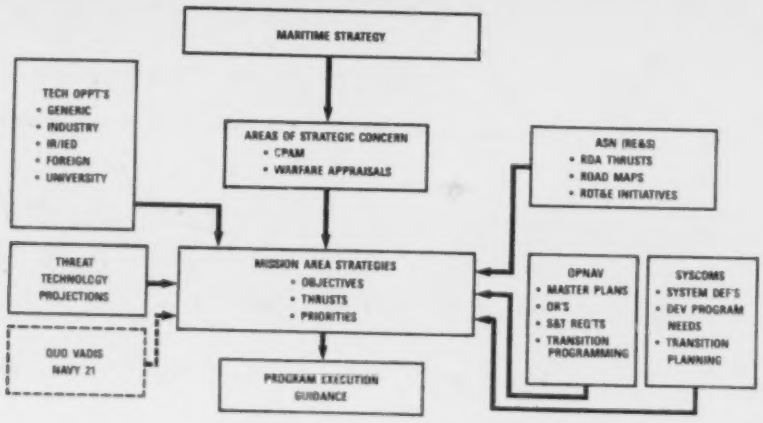
The Office of Naval Technology is led by Dr. Philip Selwyn, who has a doctorate in chemical physics and entered Government service in 1976 through the DARPA organization.

Under the 6.1 office, the Naval Research Laboratory, the Naval Ocean and Research and Development Activity at Bay St. Louis and the Naval Environmental Prediction Research Facility report to me through ONR.

I have two other offices, one in London and one in Tokyo, who monitor operations in the scientific arenas in the Far East and in Europe.

Of particular note is that the Office of Chief of Naval Research was established in 1946 to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power. This was done by an act of Congress, Public Law 588, which is not the case for my counterparts in either the Air Force or the Army.

## TECH BASE GUIDANCE DEVELOPMENT




Slide 4. In developing our programs, we draw upon multiple inputs, including requirements, threat assessment, available technology, and strategy to conceive of annual program guidance—research requirements for basic research, and mission area strategies for exploratory development.

## NAVY BASIC RESEARCH (6.1) PROGRAM OBJECTIVE

**FULFILL THE ONR MISSION BY PROVIDING SOURCES OF NEW CONCEPTS AND TECHNOLOGY OPTIONS THROUGH:**

- **THE SUPPORT OF THEORETICAL AND EXPERIMENTAL RESEARCH IN**
  - **PHYSICAL & MATHEMATICAL SCIENCES**
  - **ENGINEERING SCIENCES**
  - **LIFE SCIENCES**
  - **OCEAN SCIENCES**
- **PROVIDING A VIGOROUS SCIENTIFIC MANPOWER & LABORATORY BASE**

Slide 5. The objectives of our basic research program are to maintain the Navy's technological lead by supporting a scientific program that is responsive to the requirements of naval warfare, and to provide a vigorous scientific manpower and laboratory talent base.

## ONR INVESTMENT STRATEGY

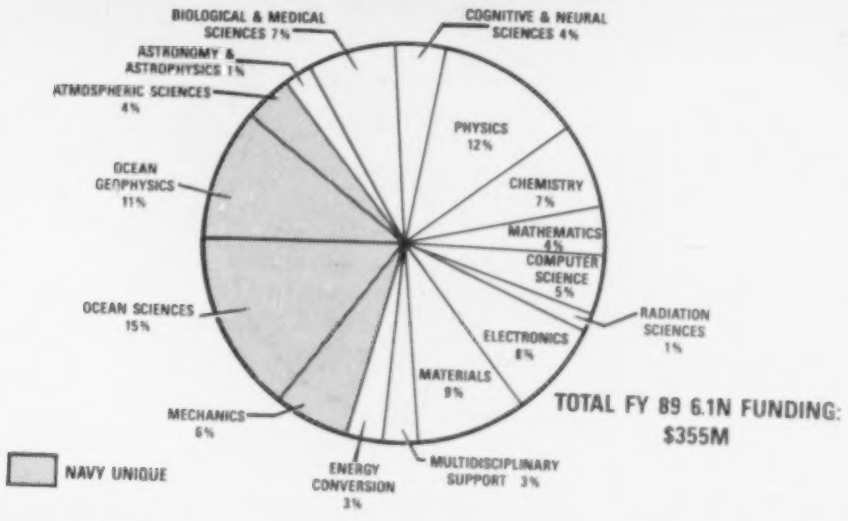
- ~ 60% - INVESTED IN EVOLUTIONARY SCIENTIFIC RESEARCH ACROSS THE SPECTRUM OF NAVY-RELEVANT DISCIPLINES
- ~ 15% - HIGH RISK/HIGH PAYOFF REVOLUTIONARY EFFORT
- ~ 25% - BASIC RESEARCH CLOSELY ASSOCIATED WITH TRANSITION WHERE FLEET APPLICATION IS CLEARLY APPARENT

Our basic research investment strategy—from slide 6—demonstrates that almost two-thirds of the program continues broad-based scientific research necessary to provide the long-term foundation of knowledge for future naval applications.

Fifteen percent of the program is allocated to fund high-risk programs with significant technological payoff if successful. The remainder is targeted to applications with defined near and mid-term transitions to the 6.2 program.

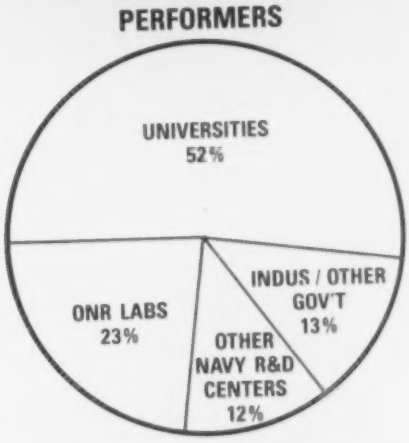
Our basic research program is parceled into areas of scientific investigation. While other areas are necessary and of vital importance to the Navy technology base, about one-third—the shaded area in slide 7—are in areas unique to naval application.

# TOTAL 6.1N FUNDING




Navy 6.1 acts as a primary source provider of ocean science and Navy relevant research in such areas as ocean acoustics, ocean optics, air/ocean interface, which are otherwise not supported by other U.S. funding agencies. Without Navy sponsorship, this research effort would probably not exist.

## DISTRIBUTION OF 6.1 FUNDS FOR FY-89



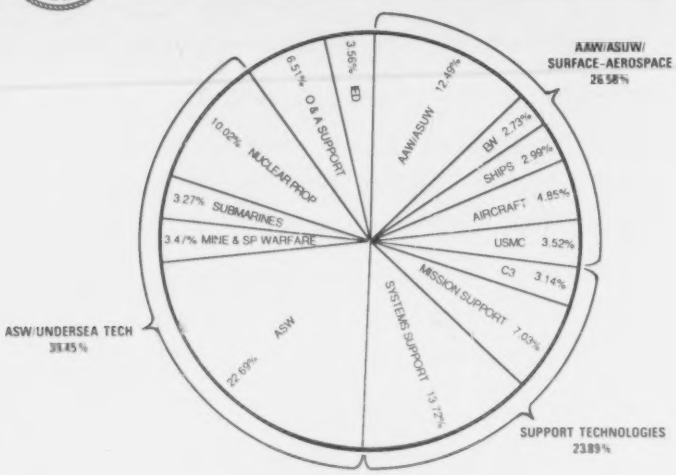

Slide 8. The 6.1 program is primarily conducted in colleges and universities across the country. A third of the program is accomplished by Navy laboratories and research and development centers and the "Other" category includes industry and nonprofit organizations.

## NAVY EXPLORATORY DEVELOPMENT (6.2) PROGRAM OBJECTIVES

- MAINTAIN TECHNOLOGICAL SUPERIORITY IN CRITICAL NAVY MISSION AREAS
- DEVELOP CREDIBLE TECHNOLOGY OPTIONS THAT DEMONSTRATE CLEAR POTENTIAL FOR TRANSITION INTO NEW SYSTEMS WHICH:
  - SUPPORT THE NAVY MARITIME STRATEGY AND ARE NAVY UNIQUE REQUIREMENTS
  - OFFER A DECISIVE TACTICAL ADVANTAGE AND/OR LARGE REDUCTIONS IN LIFE CYCLE COSTS
- INTEGRATE OBJECTIVES WITH THOSE OF HIGHER CATEGORIES OF RDT&E

Slide 9. I would like to shift to the exploratory development program. The objectives of the 6.2 program are designed to: maintain our technological superiority; investigate new technological options which have a clear path for transition, and ensure goal congruency with 6.3 and higher funding categories.

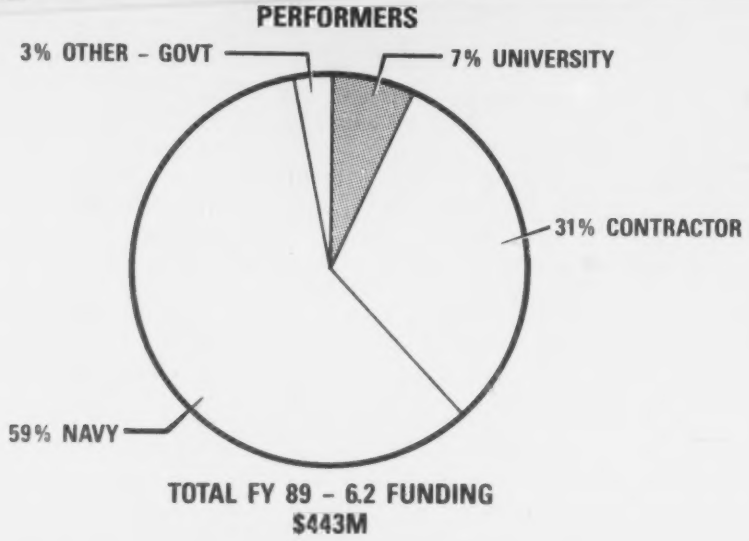
# TOTAL 6.2 FUNDING




**TOTAL FY 89 6.2 FUNDING: $443M**

Slide number 10. Our 6.2 exploratory development funding is allocated by mission area as shown on this chart, with anti-submarine warfare our major area of resource concentration.

## DISTRIBUTION OF 6.2 FUNDS FOR FY 89




Slide 11. Well over half of our exploratory development is conducted in Navy laboratories and R&D centers to further the "smart buyer" concept. About a third of this is performed by the industrial research and development sector and the remainder is done by university laboratories and other nonprofit organizations.

## SECTION 220, NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 1989

- CURRENT INTERPRETATION OF CONGRESSIONAL LANGUAGE:
  - EFFECTIVE 1 OCT 89, ALL CONTRACTS AND GRANTS TO COLLEGES AND UNIVERSITIES FOR THE PERFORMANCE OF R&D MUST BE LET USING COMPETITIVE PROCEDURES
  - MEANS THE PRESENT EXEMPTION TO MAINTAIN ESSENTIAL ENGINEERING AND R&D CAPABILITIES AT UNIVERSITIES WILL NO LONGER BE IN EFFECT
  - NAVY WILL NO LONGER BE AUTHORIZED TO WORK DIRECTLY WITH SELECTED UNIVERSITY LABORATORIES (APL/ARL/MPL)
  - THESE LABS HAVE ESSENTIAL FACILITIES AND KNOWLEDGE BASES SPECIFICALLY DEVELOPED TO MEET SPECIFIC NAVY NEEDS THAT DO NOT LEND THEMSELVES TO COMPETITIVE PROCUREMENTS
- INTER-SERVICE WORKING GROUP COMMISSIONED BY THE UNDERSECRETARY OF DEFENSE, ACQUISITION, TO:
  - IDENTIFY PROBLEMS WHICH MAY RESULT FROM NEW STATUTORY REQUIREMENTS AND,
  - DRAFT REPORT REQUIRED BY CONGRESS

Slide 12. The university laboratories were specifically designed to accommodate specific Navy needs. They have essential facilities and knowledge bases which are unavailable elsewhere. Recent congressional action in Section 220 of the National Defense Authorization Act for 1989 is threatening to undermine the special relationship Navy has with these unique institutions.

The Defense Department recognizes the seriousness of the situation and has organized a working group to study the overall impact of Section 220 on the DOD technology base.

## EXAMPLES OF CLOSELY COORDINATED 6.1/6.2 PROGRAMS

- SYNTHETIC APERTURE RADAR DETECTION AND CLASSIFICATION OF SURFACE SHIP WAKES
- HIGH-ENERGY-DENSITY EXPLOSIVES
- ULTRA-LOW-LOSS FIBER OPTICS
- ACOUSTIC TOMOGRAPHY
- OCEAN PREDICTION MODELING
- ADVANCED AIR VEHICLES
- RADAR CLUTTER REDUCTION FOR NEAR SEA PATHS
- ARTIFICIAL INTELLIGENCE
- HIGH TEMPERATURE SUPERCONDUCTIVITY
- REFRACTORY SEMICONDUCTORS
- VACUUM ELECTRONICS

## EXAMPLES OF CLOSELY COORDINATED 6.1/6.2 PROGRAMS (CONTINUED)

- LASERS AND OPTICS
- SUBMICRON SOLID STATE ELECTRONICS
- ELECTRONIC MATERIALS
- METAL-MATRIX COMPOSITES
- BIOMATERIALS
- ALUMINUM-LITHIUM ALLOYS
- REMOTE MAGNETIC SENSORS
- UNIVERSAL BLOOD AND BLOOD SUBSTITUTES
- COLD WEATHER MEDICINE
- BONE MARROW TRANSPLANTATION

Slides 13 and 14. The collocation of the Navy's basic research and exploratory development program management nurtures the spirit of cooperation. One of the keys to the program's survival is coordination and cooperation. The Navy has taken the lead in cooperative efforts on a multi-plane effort within the Navy, tri-service, DOD agency, and industry-wide. This and the next page address ex-

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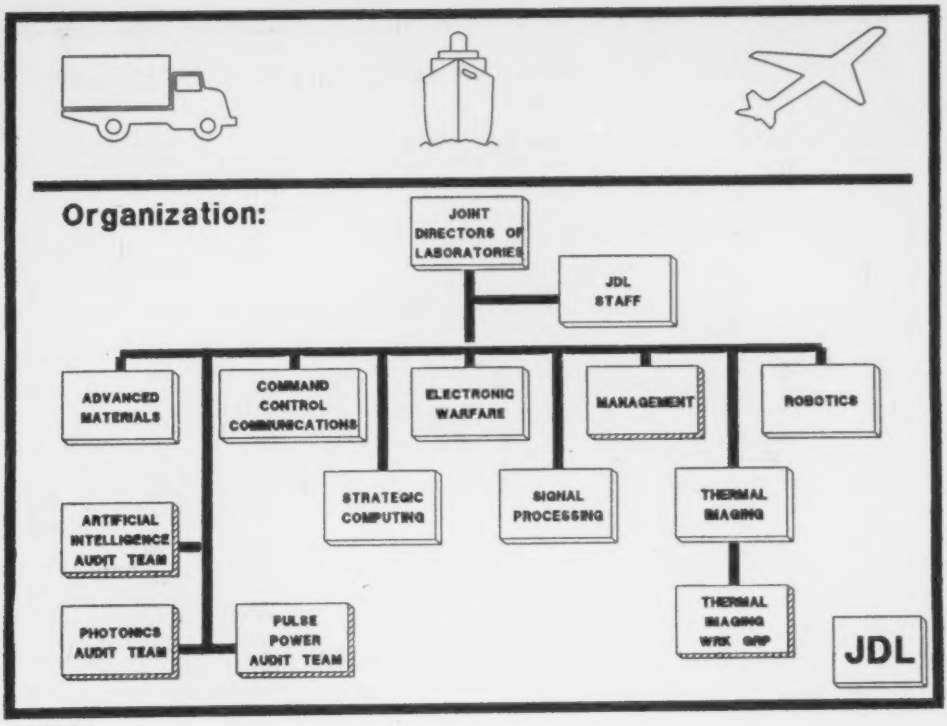
amples of close cooperation between the 6.1 and 6.2 as demonstrated by vertically funded programs within my own organization.




Slide 15. The Joint Directors of Laboratories, the JDL, is chartered by the Joint Logistics Commanders of the three services to make the most effective use of our tech base and laboratory resources through cooperative action of the three services.

The principals of the JDL control the major portion of the laboratory and tech base resource for the three services. We are, therefore, strategically postured to assure that the JDL fulfills its stated purpose.

To help us accomplish our mission we have established these technical panels and their supporting committees. The members of the technical panels and committees are senior engineers and scientists who are knowledgeable of the technology programs within their respective services. They are sensitive to the opportunities for cooperative efforts, as well as aware of the significant issues which impede efficient use of tech base and laboratory resources.

## JOINT PROGRAMS - EXAMPLES

| DARPA | SDI | INDUSTRY |
|---|---|---|
| SUPERCOMPUTING | FREE ELECTRON LASERS | SUPERCONDUCTIVITY |
| SYSTOLIC ARRAY PROCESSORS | PASSIVE SENSORS | ELECTRON DEVICES |
| POLYMER THIN FILMS | LASER SATELLITE NETWORKING | ADVANCED COMPOSITES |
| SUBMARINE TECHNOLOGY | ELECTROCHEMICAL POWER | DIRECTED ENERGY CONCEPTS |
| HYPERSONIC MISSILE TECHNOLOGY | ADVANCED PROPELLANTS | INFRARED SURVEILLANCE |

Slide 16 addresses joint programs. We are also the leader in cooperative efforts with other Defense agencies and industry. These examples are but a fraction of the total number of joint programs but clearly demonstrate the Navy is concerned about the value of the R&D investment dollar.

While I have listed superconductivity under industry, it could be listed under each of these columns. As a matter of fact, of the Department of Defense dollars—fiscal year 1989—invested in superconductivity programs, it's a $70 million effort at this point. The Office of the Chief of Naval Research manages 63 percent, or $44 million, of this investment.

# NAVY INVESTMENT STRATEGY

- **BASED ON NAVY RELEVANCE**
  - DESIGNED TO MEET FUTURE/URGENT NAVAL NEEDS
- **EMPHASIS ON COORDINATION**
  - 6.1/6.2 COLLOCATED
  - JOINT DIRECTORS OF LABORATORIES
  - IMPROVED OPNAV/SYSCOM/OCNR/FLEET INTERACTION
- **DESIRED RESULTS**
  - MORE RAPID TECHNOLOGY TRANSITION INTO HIGHER FUNDING CATAGORIES
  - COST EFFECTIVE RESEARCH EFFORTS
  - IMPROVED CONGRESSIONAL AND DOD ADVOCACY

Slide 17. In summary, Navy basic research and exploratory development programs are initiated to address Navy needs. We have made great strides in cooperative programs and are convinced that joint programs will more quickly achieve desired goals of many of the Navy's technology programs.

The Office of the Chief of Naval Research continues to strive for rapid transition of technology base programs to higher funding categories through efficient use of our resources, and with the intent of gaining your trust and your support.

# TECHNOLOGY IS THE NAVY'S FUTURE

Our future is dependent on it. Thank you, sir.

Mr. HERTEL. Thank you, Admiral.

Mr. FAUGHT. Mr. Chairman, I have two other points and then we can open it up for further discussion.

We have talked a lot about ASW organization. This past year, as I mentioned earlier, the Navy has taken strides to bring all ASW systems together for more coordinated management.

Last month, the Navy selected Rear Adm. Dan Woltensdorfer to head our ASW development operation. He comes to us from being the Commander Operational Test and Evaluation Force which, of course, is our Navy-wide test activity. I would just like you to recognize him here today.

Last, on page 8 of prepared remarks, I have three pie charts that demonstrate where we are today and where we're going in our overall R&D budget. I think that is a good introduction to our budget and program discussion today.

I would like to make a couple of points about page 8, if I may. The pie chart on the bottom represents a projection of where we will be in terms of budget allocation in the year 2005. I want to make one emphatic statement, and that is that this plan between 1994 and the year 2005 is preliminary. In addition, the plan on Facilities and Equipment will take us out to 2010. But these are preliminary and, of course, they have to go through a number of steps before they become solidified.

The division of warfare activities insofar as our entire 6.1 through 6.6 R&D budget is concerned, will follow lines similar to these. As you will notice, submarine/anti-submarine warfare this year and the next roughly makes up a quarter of our budget. You will notice in 2005 that slips to somewhere around 19 percent. I must emphasize again, in absolute terms that represents a considerable increase.

The difference in the budget from fiscal year 1990 compared to the year 2005 largely rests in the increase in our strategic warfare development. A major portion of that—which we can talk about later if you wish—centers on the need as we see it for some follow-on in our TRIDENT system.

With that, Mr. Chairman, we are ready to entertain questions.

Mr. HERTEL. Thank you very much, Mr. Secretary.

I have, first of all, a series of questions on Navy contractor support services, but they are somewhat detailed. I will just submit those for the record for you to answer at a later time.

Mr. FAUGHT. Thank you.

[The subcommittee insert will be provided at a later date.]

Mr. HERTEL. Mr. Davis and I are very interested in the progress of the laser submarine communications systems. Could you summarize for us, Admiral, where that is now as well as discuss the February 7th meeting that you had with DARPA?

Admiral MCCARTHY. Yes, sir. We have been working for about 5 months with DARPA to develop a joint program that will effectively do the things that both of us would like to do to complete the direction of Congress last year as far as providing a demonstration program in the TALC area and to bring more closure in the SLCSAT arrangement.

We have come up with an agreement. That agreement is in the process of being signed. It takes the funding and spreads it out over 3 years. It does the demonstration program in TALC. It puts more emphasis on the solid state laser. It continues some low level work in gas laser. It does system engineering, risk reduction, and concept work.

What we really need to do in the SLCSAT area, we feel, is to find the most affordable technology and come to grips with the delta that we see in the price. What is the cost of the SLCSAT program? The cost of that ranges anyplace between $1 and $5 billion for the first satellite. What we need to do is collapse down more to a point figure.

We think that with the work that we will be doing with DARPA over the next 2½ years in that program, we can narrow that focus.

Mr. HERTEL. Why is the estimate so wide ranging at this point still—from $1 to $5 billion?

Admiral MCCARTHY. It depends, to some degree, on the type of a system that you have up there, whether it's a gas system or whether it's a solid state system. It depends on the number of satellites that you have up in orbit. It depends on the ground station arrangement. It depends on the connectivity that you have out in the fleet.

Mr. HERTEL. Are we ready at this point to make those decisions, though, Admiral?

Admiral MCCARTHY. No, sir, we are not. I didn't mean to imply that we are. We would probably need about another 2 years beyond what we are doing right now before we can get to a good decision point.

Mr. HERTEL. When do you think we would be ready to put a solid state satellite under the program?

Admiral MCCARTHY. I really can't answer that because it's one of the questions that we are going to have to answer from the study.

Mr. HERTEL. Are we talking about the next century?

Admiral MCCARTHY. We think that if we have a 4 or 4½ year program, we will be prepared to make a decision. So about the 1995 time frame you could make a decision on what you wanted to go with, what type of a communication system.

Mr. HERTEL. Are you telling us the technology is there?

Admiral MCCARTHY. No, sir. If you wanted to put up a laser at this particular point to do single communications from a satellite you would use a gas laser. We think that the most promising laser that is coming at the turn of the century, perhaps a little bit beyond that—is a solid state laser.

Mr. HERTEL. How much is in the budget for it for 1989?

Admiral MCCARTHY. There is $50M in 1989 which will be spread over 2 years. There is nothing in the budget for 1990.

Mr. HERTEL. Isn't that part of the problem of being able to reach decisions—if there's nothing in the budget?

Admiral MCCARTHY. Nothing in the budget for 1990.

Excuse me, let me correct that. There's $2 million in the budget for—2 million for 1990 and 2 million for 1991. Both of those years share in the 3 year effort with DARPA that I spoke of earlier.

Mr. HERTEL. Why such a low number?

Admiral MCCARTHY. The number is low because of the lack of confidence in where we really are as far as laser communications. Do we really believe we can do it? What truly is the cost of the SLCSAT arrangement?

Mr. HERTEL. Do think there is some doubt that we can do it?

Admiral MCCARTHY. I don't believe there is any doubt that you can take a laser and put it up in space. It may take you a while to do that. You are going to have to qualify the laser. But the questions are how often you can use that laser; what the reliability of that laser will be; how many shots you can get out of it; what the number of words of code you can send down through that laser system, or whether you can in fact get some type of a return up.

Mr. HERTEL. Maybe we will come back to this later today. I don't want to take up too much time in the Chair here.

Let me, before I forget, say to Admiral Wilson that we share your concerns about the change in the law regarding competitive contracts of all kinds of university research, because of the unique investment and experience that some universities have devoted already.

In fact, I met with many of those universities here in Washington last week, and I think I understand the problem. If I recall, that change in the law was done on the floor of the House, wasn't it?

Admiral WILSON. Yes, sir, it was.

Mr. HERTEL. So some of the specifics were not addressed when that amendment was adopted. So I think we might revisit some of the questions and some exceptions in that regard, Admiral.

Admiral WILSON. The OSD committee is scheduled to report out at the end of this month, and I am told at that point in time there will be some recommended language to fix this.

Mr. HERTEL. Thank you.

Admiral McCarthy, we move to a different area. We see that now into the future we are talking about a 4 percent total of the budget

for research in general that's projected into the future. The table that we're looking at, the Secretary directed us to on page 8, I believe.

Mr. FAUGHT. You mean the 6.1?

Mr. HERTEL. Right.

Mr. FAUGHT. We have 4 percent in basic research, correct. We are shooting in the future for 6.1 and 6.2 about 8 to 10 percent of our budget. But, currently it's both 6.1 and 6.2 is a tech base about 7 or 8 percent.

Mr. HERTEL. This is always a general question, but do you feel that's enough? Do you feel that you need more as far as research now and in the future?

Mr. FAUGHT. I guess this is the time I've been told to say this is a personal opinion, so I will do so.

No, I don't think it's enough. Historically, the Navy had about 10 percent of the RDT&E budget—in 6.1/6.2 activities. I believe that there are a number of areas that could be supplemented if we could afford more, particularly in the field of education. We do have, coming down the pike, I think a major crisis in the Americans who are not educated in the scientific disciplines.

But for the time being, it will be a process of building the tech base up to roughly a billion dollar level. In our plan, which you will see, we are endeavoring to do that as quickly as possible.

We believe that 6.1 should be about 40 percent of that total, and 6.2 would be the other 60 percent.

Mr. HERTEL. Now, when this budget cut comes down from the President's number, will research be protected at the same percentage, the same dollar number, from that cut?

Mr. FAUGHT. Congressman, I have every reason to believe that will be generally the case. There's a lot of birds flying around in the air, as you know right now. We went through a drill last week on this, and the tech base around the $391M for 6.1 and 6.2 at the $412 million level at that time.

Mr. HERTEL. Thank you.

Mr. FAUGHT. You're welcome.

Mr. HERTEL. Admiral Pittinger has been very helpful in working with us and giving us information about the programs in oceanography. It seems to me with the Soviets doing so much, having so many more ships than ours; we have 14 ships in that oceanographic fleet of the Navy; the Soviet Navy has 150, for instance.

We have to learn so much more about the weather at sea. We have to learn so much more about the cloud formation at sea. All these things, of course, will be valuable to our Nation but especially to the Navy.

Do you think in that area, Admiral, again the question, are we spending enough in the area of oceanographic research? I know it has come up recently higher than it was in years past. But do you think it's adequate today, Admiral?

Admiral MCCARTHY. There is no question, Congressman, that if you wanted to do more in that area you could in fact do it. We feel that given the constraints that we're under with the budget that oceanographic research is about right.

Mr. HERTEL. We appreciate what you're doing in that area and would like to work with you further.

I don't want to take up more time at this point. I ask if Mr. Stump is ready?

Mr. STUMP. I pass, Mr. Chairman.

Mr. HERTEL. OK.

Mr. Hochbrueckner.

Mr. HOCKBRUECKNER. Yes, Mr. Chairman, thank you.

Mr. Secretary, I am delighted to see in your biography there that you were an enlisted man in the Marine Corps before becoming an officer. Having been an enlisted man myself, I can certainly appreciate having someone coming from your kind of background.

In reading your testimony, on page 2 you indicate that R&D efforts were in balance toward new systems, new platforms, and new weapons with inadequate attention given to improving, modernizing, and upgrading proven, existing assets.

Mr. FAUGHT. Yes, sir.

Mr. HOCKBRUECKNER. On page 7, you list some of those areas that in fact are being canceled or deferred. Of course, one of them is the A-6 remanufacturing of the A-6G.

One of the concerns that I have is I am under the impression that the fleet is very interested in upgrading the A-6E to an A-6G model. As you know, we had a major fight over the last couple of years, to move toward an A-6F version; and, of course, the A-6F died. President Bush indicated that it was dead, while the Senate finished it off a year and a half ago. But, obviously, that left us with an option which was to continue to provide the Navy with a strong medium attack capability until the ATA would come along and eventually replace the A-6.

The concern that many of us have is that we do in fact need a smooth transition from the A-6 aircraft to the ATA, eventually. Clearly we are going to have A-6's around for a long time to come.

Having worked on the original A-6A aircraft myself when I was at Grumman in the 1960s, I know it to be a solid aircraft, especially with roughly 340,in the fleet that we are going to put new wings on as well as composite wings on virtually all of them.

I have never seen a major aircraft program that has not in fact slipped, so my concern is that we are left in a situation where we will have a fleet of A-6E's for many years to come until they are replaced. Clearly we have an aircraft, which as you cited by your concern, is an appropriate weapon system that we need to stick with in terms of upgrading existing proven assets. Clearly, the A-6 is a proven asset. It is certainly the main thrust of the Navy in terms of their ability to project power around the world.

My concern is that the administration canceled the A-6G program back in December, notwithstanding the fact that Congress, in December of 1987, was successful in putting additional money into the budget after the A-6F died, to continue the research and development on the A-6G and, of course, to buy some new A-6E's in order to keep the fleet modernized.

But my concern is, if in fact we're going to put wings on 340 A-6E's, doesn't that make sense for us to go by the words that you have written here, and in fact, by taking a proven asset and upgrading it to a G model so that whether ATA is on time or whether it slips, that we end up with a smooth transition in terms of

medium attack capability for the Navy through this transition period. That's the concern we have.

We were very surprised, in light of the fleet's need for the upgrade, why in fact the Pentagon decided to cancel the program in December, which we regard as bad news.

Obviously, going from an A-6E to a A-6G gives us some things we don't have now, certainly 30 percent more power, an upgraded aircraft digital avionics. The digital avionics' stand-off capability is extremely important in these days of improved radars on the other side and what have you.

So I would ask you, what is your feeling about the A-6G in light of your own statement of support for proven assets?

Mr. FAUGHT. Congressman, I am going to divide this task up between Vice Admiral McCarthy and myself.

As you so clearly pointed out, this thing has been really quite a conundrum in the last year. The Navy realizes the value of that aircraft. We tussled for a long time between the funds we had and the A-6G. We tried several—rather innovative approaches to planning between the A-6G and the SWIP and the remanufacture and redesign and various other things, because, as you so thoroughly noted, it's a very valuable asset, and it's going to continue to be a valuable asset to us for some time.

I have learned this word, and I detest it, but it comes up time and time again, and that's "affordability." That is somewhat of a box we find ourselves in. If we did what we would like to have done 2 years ago, a year ago, again, as you pointed out, we would have upgraded that airplane substantially.

I would like Vice Admiral McCarthy to address this point.

Admiral MCCARTHY. Many of us who have flown the A-6 really respect the aircraft. It has been a good weapon system. We watched that plane become operational in the United States Navy in 1965, and it did a superb job in the fleet. Even though the A-6 is an all-weather, medium attack, with substantial capability, it's yet limited by it's 1950's technology.

We have in fact improved it with the A-6E. We are introducing capabilities to accommodate stand-off weapons which will bridge the gap over where we are right now and where we need to be in 5 years.

We have limited resources and we've somehow got to deal with that issue. That issue really looks at what we can provide the fleet. It's the Navy's position and it's our decision that the best system to pursue is the ATA. We have managed shortfalls in the past, and we know that we are going to be into a deficit position as far as shortfalls this time. But, we are looking forward to getting the ATA.

Mr. HOCKBRUECKNER. Admiral, we all agree that the ATA is going to replace the A-6. There is no question about that. I don't think there is one detractor in the Congress who would say that the ATA will not in fact replace the A-6.

The question is, how to have the smoother transition between the A-6 and the A-12. That's the concern here, is we don't want to see the Navy naked in terms of medium attack capability at a time while we're waiting for the ATA to come along.

My point is, if we're going to spend $6 or $7 million a copy, putting wings on all of the existing A-6E's, does it not make sense to go ahead with the original program that the Navy proposed, and the Navy desires, that in effect was killed by the Pentagon, which would be to take half of the A-6E fleet, make them into A-6G's, and guarantee a smooth transition whether ATA's on time or not.

That's really the issue here, is where do we go from here, recognizing the priorities that exist based on the money that is available.

Admiral McCarthy. Congressman, we would like to be able to do that. We just cannot financially afford to do that.

Mr. Hockbrueckner. OK.

The second question. I was enthralled by this particular chart that was presented. The Admiral indicated that one of the areas that's in the 6.1/6.2 programs is submicron solid state electronics. I was wondering if someone could define for me what particular program you are talking about.

Is this a Navy version of x-ray lithography or is this some other program?

Admiral Wilson. What we are talking about is molecular beam epitaxy—which is a magnitude smaller than the x-ray lithography.

Mr. Hockbrueckner. So instead of a quarter of a micron, which we would get on the x-ray, you are talking about a tenth of a quarter of a micron?

Admiral Wilson. Yes, sir.

Mr. Hockbrueckner. I would love to see it, I would be impressed.

We could have the AYK-14 airborne standard Navy computer on my wristwatch if that's the case.

Admiral Wilson. Almost. You're talking about the x-ray lithography kinds of technology, you could forecast that you could put a computer in a shoe box. Now we're going to put it in a cigarette carton.

We have a very modest joint program in 6.1 research in x-ray lithography, but that's in a broad decline. It's not something that we consider basic research or broad technology. There are major companies that are manufacturing components with x-ray lithography.

Mr. Hockbrueckner. We will come talk to you about it. I would be fascinated to learn about that.

One last question, if I may, Mr. Chairman.

I am under the impression that in the fiscal year 1990 budget, the Navy has requested almost $95 million for a Navy version of ASAT—an anti-satellite system. It's listed under unclassified. I am just wondering why is the Navy getting into ASAT's when the Air Force just got out?

It just seems like it's a direction which is not appropriate for us at this point in light of the new relationships and agreements that have been struck with the Soviet Union.

Mr. Faught. Congressman, would it be possible to talk to you about this? We are having a hearing coming up shortly on that subject and there's some things that perhaps we would like to talk to you individually about that.

Mr. Hockbrueckner. That will be fine. Thank you.

Thank you, Mr. Chairman.

Mr. HERTEL. Mr. Kyl.

Mr. KYL. Thank you.

Mr. Chairman, I would like to pursue that subject directly, and if we need to talk about this in a classified session, fine, but I don't think that we are at a level here where we do. That $94 million is in the Navy budget and Mr. Dickinson, our Ranking Member, I know has talked to some of you folks about it, as being critical to the survivability of our Navy.

I am very interested in seeing that that money survives the additional cuts that have to be made. I wonder if you could tell me whether it is your intention, as far as you know right now, to ensure that that occurs?

Mr. FAUGHT. The subject that the Congressman brought up was actually why we're interested ASAT. I wasn't referring to the budget aspects of it.

We right now, and I'm sure you know this, are going through a drill as we speak on what we're going to do to reduce our budget. I could not promise you, sitting here now, what the outcome is going to be with ASAT in the Navy budget this year or next.

We had discussions last week. Those discussions, by no means, are finalized. We began again this morning. Whatever happens I'd like to get together to discuss what our interest is and why we're interested.

But, Congressman, I couldn't tell you, sitting here today, what the outcome is going to be on that program budget-wise.

Mr. KYL. Does any of this relate to the fact that DAB has decided that the Army ought to run the program?

Mr. FAUGHT. No, that isn't it at all. We believe that given some time—and I will have to say this is my opinion also—that Navy will probably take that program over in the future. That has nothing to do with whatever the decision is concerning the budget outcome.

Mr. KYL. Obviously it does impact with a threat impacting Navy the most. It's critical, it seems to me, that this item be protected. I don't have any idea what my colleague refers to when he talks about new relationships or agreements with the Soviet Union that have any impact on the threat that exists to our fleet, and the absolute necessity to protect this item in the budget.

What would be the reason why it wouldn't be protected? What conversations have there been that suggest that it might not be protected?

Mr. FAUGHT. The DOD is looking to take out over this year or next year somewhere in the neighborhood of $5 or $6 billion. While that certainly, in my opinion, isn't necessarily the most convincing reason in the world, in terms of priorities it is certainly one. But it has nothing to do with the need—the threat is there. We are aware of that.

Navy probably is as vulnerable as any of the services, with our assets sitting out there in water. So as in so many other of these instances, it's a matter of priorities and how we address those—and that's being addressed right now.

Again, it's not to minimize the threat at all, nor Navy's interest.

Mr. KYL. We very much appreciate that comment. One reason I may appear to be a bit insistent right here is that's this commit-

tee's responsibility—the research and development. We constantly hear talk about how we're too much into today's problems and funding older weapon systems and things that you can drive or fly or sail or whatever.

We are now talking about a long-term new threat, which I gather you agree with.

Mr. FAUGHT. A very vital one.

Mr. KYL. That has to be of very great concern to the people on this committee.

Can you talk to us just briefly about the kind of platforms that the Navy might be considering for any kind of sea-based ASAT or is this the place to do that?

Mr. FAUGHT. We can say that we're looking at several, and that doesn't answer your question. We are aware that this type of defensive weapon can, with some development, be installed aboard ship. I think we had better reserve this for a later occasion, I really do.

Mr. KYL. OK.

Mr. FAUGHT. But we are looking at that.

Mr. KYL. We would sure be interested in pursuing that.

Mr. FAUGHT. We look forward, with pleasure, to discussing it with you.

Admiral MCCARTHY. Just to add to the Secretary's comment on the hearing, I think it is scheduled for mid-March. I'm not sure of the exact date.

Mr. FAUGHT. The 15th of March.

Admiral MCCARTHY. OSD has the lead on this, and that's why we're being careful as to what we say. There are in fact two concepts. One concept is a Navy concept and one is an Army concept. I think at that time OSD will pretty much lay everything out and go through it.

Mr. KYL. Thank you very much.

Thank you, Mr. Chairman.

Mr. HERTEL. Mr. Stump?

Mr. STUMP. Thank you, Mr. Chairman.

Mr. Secretary, the Reagan fiscal 1991 was some 5 percent lower than 1990 with some falling out of engineering and development. Could you tell me what——

Mr. FAUGHT. You are referring to fiscal year 1989 versus fiscal year 1990?

Mr. STUMP. No, I'm referring to fiscal year 1990 versus fiscal year 1991, where $700 million fell out of engineering and development.

Mr. FAUGHT. We had some modifications not necessarily across the board, but over several programs. It is a matter of some programs winding down—the TRIDENT being one. It's not complete yet but it's certainly down. I think that was the biggest one among those.

Mr. STUMP. Would you supply that for the record, please, Mr. Secretary?

Mr. FAUGHT. Yes, I shall.

Mr. STUMP. Thank you.

Thank you, Mr. Chairman.

[The following information was received for the record:]

LARGE NEGATIVE DELTAS IN 6.4 PROGRAMS (ENGINEERING AND DEVELOPMENT) FISCAL YEAR 1990 TO 1991

[In thousands of dollars]

| PE | Program title | Fiscal year 1990 | Fiscal year 1991 | Delta |
|---|---|---|---|---|
| 0604233N | Adv Tactical Fighter | [Deleted] | [Deleted] | [Deleted] |
| 0604363N | Trident II | 222,154 | 70,670 | —151,484 |
| | | [Deleted] | [Deleted] | [Deleted] |

Mr. HERTEL. Mr. Weldon.

Mr. WELDON. Thank you, Mr. Chairman.

Mr. Secretary, it's a pleasure to meet you. It's the first time I've had the opportunity as a new member of this subcommittee. I look forward to working with you in a close working relationship over the next several years.

One of the reasons I joined this subcommittee was to complement the work that I've been doing on the Seapower Committee, specifically as it relates to Navy. I look forward to working with you on the new weapons systems that we're currently developing and implementing, as well as the efforts of electric propulsion, which, as you know, is a major priority of the Navy for the next several decades.

As I read through your testimony, I was somewhat struck by the lack of discussion on that issue in your testimony. But, I understand it was fully discussed by other individuals here, recognizing the importance the Navy is placing in this effort for the next 10 to 20 years.

I have some parochial concerns that I'll work with you on relating to the V-22, the LHX, and the whole advanced composites technology area, which I think is a major area that we have to spend a great deal of effort on in the future for our long-term viability in combat missions.

I will also be looking to work with you in the very specific area of life, safety, and survivability concerns for the men on board our combat ships. I have spent a great deal of my time on the Seapower Subcommittee getting to know what the Navy has been doing and perhaps what it should be doing to spend more time in the area of research and protection for the men on board our combat ships, especially following the lessons that we learned in the attack on the *Stark*.

I might say that I'm not completely happy with what I've seen. The one hearing that we had, Chairman Bennett and I were very actively involved last October on some very specific items that needed to be procured to bring our fleet, our combat fleet, up to snuff in terms of providing state-of-the-art technology for our sailors that just was not made available because of procurement problems and simply because of an acquisition process you could not respond to life-threatening situations.

For the record and I don't expect you to respond to this today, I'd like you to provide for me and for the committee, if the chairman will agree, a comprehensive assessment, of what efforts are currently under way in the research area on new technologies to pro-

tect the lives of our sailors on board our ships, and especially ship survivability issues.

This would include such things as breathing apparatus, smoke control, protecting electrical cables from fires, better packaging materials, expediting of procurement of trainers, smoke packaging, better packaging materials, more fire resistant hydraulic fluids, better technical information, and a list of other items that I'll provide for you.

Just to take one example, for instance, it really is unbelievable to me that we still in the Navy are using the OBA breathing apparatus on board our ships when this technology was thrown away by the public fire protection forces 30 years ago. If you read the account on the *Stark*, one of the big problems we had was a complement of men attempting to use equipment that didn't have enough canisters. If it were not for the other ships that came alongside and provided those spare canisters, we could not have maintained the ability to control that fire as our brave men did on board that ship. This technology is totally outdated.

The arguments against the OBA is because we need the conditions of space and we don't access because of the configuration of our ships to use state-of-the-art, self-contained breathing apparatus. If you talk to NASA, they've had this current technology in place for years—and they have the same space constraints that the Navy has.

I don't think that we are protecting, as we could be in terms of new research, our sailors on board our ships. I'm going to be asking, perhaps not just for today, but for the rest of this session, for an ongoing dialog with the Navy on this and other issues relating to the safety of the lives of our men on board our ships.

I am going to, as much as possible on this committee, focus the attention on making sure that we're doing everything possible to protect those men during emergency situations. I don't think we've been doing that.

Perhaps that's an overgeneralization, oversimplification, but I will be glad to give you more specifics on other areas and other technologies as time goes by.

Finally, I'd like to ask you to work with me and this committee on somehow achieving a process of expedited procurement for life safety and ship survivability technologies.

Let me give a word of praise to Captain Taussig, USN (ret.) who I work with very closely—an outstanding individual who is on top of ship survivability and life safety issues. I know the frustrations that he goes through in trying to procure the equipment and technology to implement the changes that we know are necessary to protect our sailors.

I can guarantee you from this one member's standpoint, I will be your voice here, but I also expect the Navy to respond. So I look forward to working with you.

Thank you.

Mr. FAUGHT. Congressman, we are looking forward to working with you, also, and thank you for your remarks.

There's not one of us here that do not share in spades your concerns. We have, and you will see this in the report and you will receive as part of this record, we have advanced a considerable

R&D effort in the area of training, human factors, and safety. But that certainly does not respond directly to your question, and we will do for the record, and so promptly.

Mr. WELDON. Thank you.

Mr. FAUGHT. Thank you.

[The following information was received for the record:]

*Navy Firefighting and Damage Control Research and Development Priorities.* The Navy has focused on supporting those survivability research and development projects that have the highest priority and the highest payoff. Doctrine, training personnel protection, and construction materials form the priorities in the firefighting area; doctrine, training, and equipment in the damage control area.

*Emphasis on Non-developmental Items.* Significant results have been made in research and development using the non-developmental item approach. Water based interior paints are approved for use on board ships; light weight low smoke electrical cable is now being installed in all new construction ships; and fire tolerant chill water pipe insulation, electrical cable coatings, and packaging materials have also been approved for use in ships.

*Personnel Protection.* A firefighting ensemble is being developed to replace the individual pieces of personnel fire protection equipment used in the fleet. This ensemble includes a helmet, coveralls, and boots. Personnel working in machinery spaces are being issue fire resistant coveralls; anti-flash gear is available for all personnel on board ships.

*Test and Evaluation Facilities.* The large scale and the small fire test facilities are being used extensively to test and validate the performance of new materials and equipments under actual fire conditions. Recent testing has included portable smoke curtains and thermally protective (intumescent) coatings for application to vulnerable aluminum and steel structures.

Mr. HERTEL. Mrs. Byron.

Mrs. BYRON. Thank you very much.

I have a line of questions that I have been pursuing in the other panels that concerns the challenges that you see, Mr. Secretary, coming down the road for your Navy R&D programs with the critical shortfall of the scientific community and the technical trained personnel that are necessary to follow along in the initial phase of development of many of the programs.

Obviously, you are aware of that situation. Do you have any enlightened proposals that we could look at to overcome those challenges?

Mr. FAUGHT. You are not quite a "straight lady" but you're almost, because some of our concerns are right down that alley.

We have, in the report you will receive, a proposed or preliminary long-term plan, out 15 years, for personnel. Recognizing that not only the Navy, but the Nation, indeed, is facing now, and will continue to face for sometime, a critical shortage in the types of people we need—both scientific and technical. We are endeavoring from our vantage point to try to do something about that.

In your absence earlier, I did refer that we are doing more, and we intend to do even more in the future. For example, providing education opportunities within the Navy labs and the various research centers to encourage the young people who just recently started in industry or are still in universities to find their career—and maybe this is a rather parochial interest—but in Navy research.

We do have several problems and we could talk all day on these, but they are very important, and I would like to allude to a couple. This is not to say, though, Navy is innocent and the Congress is totally responsible or anything of that nature, but some 10 years

ago, people even then recognized the problems we had in treating not better, but differently, let's say, the technical type people. They are a very highly competitive commodity. Industry and universities are as interested in computer specialists as we. As you know, that's been a very competitive area. But some 10 years ago, we launched into what was then a 2-year experiment at China Lake and NOSC (Naval Ocean Systems Center) not necessarily directed toward better compensation but a system to give the managers in those respective areas the judgmental benefit of being able to promote and to reward on merit. That program has been very well received and the Congress certainly should get high marks in permitting us to do that. It is still going on. It has been extended now a number of times. In fact, I think we now have still another extension. But we have not been able to expand that.

We have 15 laboratories in some 16 States and the District of Columbia, and we have been endeavoring to extend that one experiment to cover those laboratories. For a variety of reasons, and I'm sure they all have some merit, we have not been able to do that. We would welcome help in that area.

Mrs. BYRON. It seems to me that you used to have the exciting programs in the early development stages that would be enough to bring the top, the cream of the crop into your arena. Today, with, as I said before, the difficulty in the funding levels and the continuity of those programs, it added another dimension. When somebody looks to get involved into a program and wants to start in the early stages of planting the seed in the development and then the funding levels go on such a cycle as we mandate from this body, they get discouraged very early and very easily.

Mr. FAUGHT. We still have exciting programs. I think there's an element of that, but just yesterday we were talking about compensation. We have, for example, an optics technologist starting out with his doctorate degree, that is eligible for the top Federal pay, which if I recall correctly—and Smoke can correct me if I'm in error—is somewhere in the neighborhood of $52,000.

Admiral WILSON. Forty-one thousand dollars.

Mr. FAUGHT. The university community for that same level pays roughly 25 or 30 percent more. This is not industry, this is university. So that gap is actually widening. I'm sorry, Smoke, you're right. Optics technologist, $41,000. A physicist, Federal salary $40,000, $49,000 in university. Industry is even more. A computer scientist—this sounds like big money and you people have been through this pay raise business——

Mrs. BYRON. You are talking to the wrong crowd right now.

Mr. FAUGHT. Pardon.

Mrs. BYRON. You are talking to the wrong crowd on that issue this week.

Mr. FAUGHT. I know. The computer scientist was offered $76,000 compared to university, $94,000. So while we have very interesting assignments and very interesting work, people do have kids that go through college and other things. Pay is one of the barriers.

The other point we have is we are endeavoring to improve the working conditions and so-called work lifestyle of the people. We're replacing our laboratory buildings on the basis of a 200-plus year cycle. I come from industry and we'd be out of business if we went

over 20 or 25 years. We recognize that we first had to rebuild the Navy, its fighting forces, and Marine Corps.

We have to now, I think, we must give a little more attention to the basic infrastructure which made that Navy possible. Those two areas, the people and the facilities, are those areas we have to give attention to.

Mrs. BYRON. Mr. Chairman, I have one further question to Admiral McCarthy.

Since the conscious decision was made to go with Sealance as opposed to VLA, where are we with this program, and what does Sea Lance bring to the Surface Standoff Weapon Program? Have the funding levels been adequate to meet the potential needs?

Admiral MCCARTHY. Mrs. Byron, we feel very comfortable with where we are. We had, as you know, taken a look at combining these programs many years ago, but decided to go separate ways. Last year we brought them back together, and basically we feel very comfortable in combining the Sea Lance and VLA programs. We believe we have adequate funds and the program seems to be on track.

Mrs. BYRON. I can ask General Franklin a question. I don't want you to feel that you were here for naught.

[Laughter.]

Mrs. BYRON. On the V-22 programs, reports that we hear are less than satisfactory for the first attempted flight: airframe construction problems, too heavy, flight control problems.

Could you give us your assessment of how that program is?

General FRANKLIN. Yes, madam. Let me discuss the Marine Corps operational needs and then I'd like to let Bill Schaefer, who's sitting in the room, give you the specifics, the programmatics. He knows exactly what's going on.

The V-22 is the commandant's absolute number one priority.

Mrs. BYRON. I know that.

General FRANKLIN. Today, we are flying the old H-46 helicopters. Some of the troops flying in the H-46 are younger than the aircraft. It first came in the inventory in the 1960s.

Mrs. BYRON. You're not alone on that either.

General FRANKLIN. The over-the-horizon assault absolutely depends on our ability to start from 200 miles at sea. An example—if we were asked to go to someplace like Panama or some other place in that part of the world, today we would have to tear our helicopters apart, put them in C-5's, fly them down there, take them out of the C-5's, put them back together, and a day or so later get back into combat. Then the people would have to come by separate transport.

With the V-22, we can fly to Corpus Christi, TX from El Toro, Ca, load the troops, and assault from Corpus Christi to Central America. There are just unlimited possibilities with that aircraft.

We do have a little trouble getting it in the air, and I'd like Bill Schaefer to give you the programmatics, if you would.

Mrs. BYRON. That's passing the buck in the finest manner.

Mr. SCHAEFER. When we originally signed the contract, the V-22 was a brand-new technology airplane. It's roughly 76 percent composite material, 24 percent metal. When the contract was signed 3 years ago, the contractor estimated the first flight—would be June

of 1988. The Navy was more realistically estimating the first flight realistically was going to be in the November–December time period of 1988.

We found, the contractor was over-optimistic on his flight schedule and over-optimistic on how quick his composite technology work was coming together. You must remember, there are two major prime contractors for the V–22 that are both feeding components to each other. They have had some soft integration problems. One of the two biggest problems we ran into was the gear box test stand. The test stand was built to allow the contractors to do the rotor run-up high-power tests. The test stand did not function as designed and considerable time was lost fixing the test stands. A lot of the planned test stand testing was deferred to the actual flight vehicle.

The other problem they have had which probably cost the contractor several weeks, is the Dallas-Fort Worth weather. The V–22 testing phase that they're doing now is all outside. If they have bad weather, they don't test.

Mrs. BYRON. June 1988 to March 1989 isn't 2 weeks of weather.

Mr. SCHAEFER. No, madam, but the Government's estimate has slipped from November–December 1988 to our current estimate of sometime in the next couple of weeks.

We have some concern that the contractors may not know the critical path they're on. We've put together a blue ribbon team, called the V–22 independent executive review team headed by NAVAIR. It has representatives from both the Navy, other services, and outside the services. Its purpose is to take a technical scrub on the program, to see if Bell Boeing knows where they are technically and to look at the costs. Are there production cost savings that we can achieve by implementing changes now? The team will also review the Government's competitive production procurement competition strategy. That team is meeting at both Bell and Boeing this week.

Although we're comfortable with the program right now, we wanted to have an independent look at it.

Mr. FAUGHT. I just might add, I talked with them this morning, and as the Commandant said yesterday or the day before, the indication is that the first flight will be March 15th.

Mr. HERTEL. General, let me ask about the Dragon III anti-tank program.

Mrs. BYRON. Could I?

Mr. HERTEL. Go ahead.

Mrs. BYRON. I just would like, if you will, when that blue ribbon panel is completed, if they will submit a copy to the committee of their report.

Mr. FAUGHT. Will do.

[The USMC report was not received at time of printing.]

Mr. HERTEL. General, why can't the Marines just use the Army anti-tank, advanced anti-tank weapon system (AAWS–M) instead of updating the Dragon?

General FRANKLIN. As you know, the issue on the Dragon III versus AAWS–M has centered on the question of availability and affordability. We are very, very pleased with the Army's decision to

go for the "fire and forget" technology. We think that was absolutely the right decision.

Frankly, we still have some concern—there are 3 years and $400 million of R&D left; and in a falling budget, this kind of program has a tendency to slide. We have pursued Dragon III as the cheap alternative and, frankly, as an insurance policy.

We would dearly love to have AAWS-M if we can afford it. Early in the learning curve that's going to be a very expensive system. Four years into the learning curve we fully intend to buy the AAWS-M. Of course, last year, Congress gave us 8,000 Dragon missiles and some money to refurbish them. That will carry us until about 1997, and it will be about the time we would plan on moving into AAWS-M if it is, in fact, a successful program.

We are also looking for an economical "high-low" mix. We have two divisions that would deploy to the European Theatre. If you're going to go to Europe, you had better take a Cadillac. If you're going to go to the rest of the world, we have two divisions that may deploy to places where the threat is at best T-72-plus, and a Model-A is just fine there. So we are looking at affordability and——

Mr. HERTEL. Is Dragon III on schedule?

General FRANKLIN. You know we had to go through a reprogramming because the Congress "zeroed" the budget and we had a zero here and we lost about 9 months. We will have a tech data package ready to go to production about the end of 1992; at that time we have to come back to the HAC and lay out the program and say, all right, what would you like us to do?

That was the agreement made with Mr. Chappel last year; we were to get the research done, get the tech data package, and then come back.

Mr. HERTEL. Can you tell us what the numbers will be for the M-1 tank in the budget, in the Marines?

General FRANKLIN. In 1990 and 1991, it's a buy-out. I think the number in 1990 is 155, and 1991 is about 255 tanks. Somewhere around a total of 476, as I recall. We purchase long-lead items in 1988 plus the 66 tanks in 1989 that were put in by the HAC.

Mr. HERTEL. Is that still under negotiation or is that definite those numbers for the M-1?

General FRANKLIN. As far as we know.

Mr. HERTEL. That's what you need.

General FRANKLIN. They are still good numbers.

As you know, as Mr. Faught said, this is 1500 (time of day) and those are probably good until 1530.

Mr. HERTEL. But that's what you need, that's what you believe——

General FRANKLIN. Yes, sir.

Mr. HERTEL. Thank you.

I've got a series of questions to add for the record, but I do want to just get into one area briefly, Admiral.

In mine warfare, I know it's not glamorous and hasn't been very well supported. I'm probably one of the few that's been down there to Charleston to the mine school that you have.

What's the condition of our current mine defense ships and what are R&D programs to deal with the menace currently in——

Admiral McCarthy. This is Dr. Ed Tunstall.

Dr. Tunstall. Sir, I am the Director of Navy Laboratories.

I just left our facility in Panama City, FL, which is the mine Defense Laboratory for the Navy. We currently have 21 aging MSOs, 6 of which are in the Persian Gulf, as you are aware of.

Mr. Hertel. We only have 21 still?

Dr. Tunstall. I think the number is 21, sir.

We now have one MCM–1 ship afloat and in commission, which is undergoing trials and development of its weapon systems. The weapon system aboard that ship consists, right now, of the SQQ–30 sonar, which is an upgrade of the SQQ–14 sonar, and it will soon have—I think the number is 6 months, the newest sonar SQQ–32, which is the sonar that's being put on to upgrade all of these ships. The MCM–1 also has a mine neutralization vehicle on it, which is a device that is deployed a remotely operated vehicle that is from the side of the ship and is steered to the location of a mine and can either sever the cable on the mine or drop a charge next to it in order to render the mine ineffective.

The MCM–1 also has what is called the precision integrated navigation system on it. The current buy for those platforms, and these numbers are rough, is nominally 15 MCM–1's in the budget. It seems to me that we now have paid for nominally five of those and as I said, those numbers are rough.

There is the next class of ship which is the MHC–51, which is a similar—it's a smaller class of mine-hunting ship which will be used for coastal mine hunting. I think the contract has been let to build that ship. It will also have the SQQ–32 on it as a mine hunting sonar and it will also have——

Mr. Hertel. How many of those are you talking about?

Dr. Tunstall. I don't remember the answer to that, sir. I will make a stab and I'll say roughly 20.

In the airborne mine countermeasures the Navy is working on upgrading and qualifying the MH–53E which is a three-engine version of the RH–53D mine-hunting helicopter. The sensors and systems that we use on that include a towed sonar and a towed influence mine detonation system for both magnetic and acoustic mines. There is a program in R&D that's designed to drop a neutralization system off of the MH–53 that will go in and do the kill. So that's the status of those mine-hunting programs.

There is one other program that we are working with the Marine Corps—as General Franklin said, 14 percent of his R&D is going into the anti-mine warfare. That system is a laser system to look in shallow water for the mine threat in very shallow water.

So that's a thumbnail sketch of where we are on that subject.

Mr. Hertel. What's happening with the advanced sea mine that was being worked on?

Dr. Tunstall. To my knowledge, I think it has been killed.

Admiral McCarthy. The advanced sea mine program, has been stopped.

The United Kingdom has dropped out and we're back at square one right now, Mr. Chairman. We are examining program alternatives. It may well involve Captor. We should have a concept by about the midsummer timeframe concerning the advanced sea mine.

Mrs. BYRON. Would the gentleman yield for a minute?

Mr. HERTEL. Yes.

Mrs. BYRON. I believe you said 21 ships are currently in the Gulf.

Admiral MCCARTHY. Mrs. Byron, you are correct, we said that there were a total of 21 MSOs.

Mr. HERTEL. A total of 21 MSOs for the entire Navy.

Mrs. BYRON. Twenty-one. All right, how many are in the Gulf?

Admiral MCCARTHY. I believe that there are 6 in the Gulf.

Mrs. BYRON. Have we brought back some?

My question really relates to the ones that are operational in the Gulf. Are they going to be retrofitted when they are brought back, and upgraded with new capabilities?

Admiral MCCARTHY. I cannot answer that. Let me supply that for the record.

Mrs. BYRON. OK.

[The following information was received for the record:]

There are currently six MSOs in the Persian Gulf. Three will be returning to the United States in the Spring of 1989. No decision has been made as yet on when the remaining three will return. There are currently no plans to upgrade any of these MSOs with new capabilities.

Mr. HERTEL. I know this problem starts at the very top because after a ship was hit in the Gulf, and they asked Secretary Weinberger how that could happen; why we didn't have more capabilities there. Our Secretary of Defense said they didn't think there would be a mine there.

So I understand that it goes all the way up to the top. But to have only 21 ships at this time—I'm glad to hear about the report on what's being done and I know that the committee feels very strongly about this.

It's clear that what the Secretary always told us that our Allies would do that work for us is not true. We had to put all the pressure that we had in this country to get them to come over and help us in the Gulf, and thank goodness, they did, because we could not do it without them at that period. So we are just going to have to spend the money. It's not a lot of money; it's not expensive, really. It's just making the decision to do it and it's something now that has proven to be a need. We've had Congressman Hart, that used to be here, talking about it all through the 1980s and he was always told the Allies would always be there. We know that that's not a fact. They can always disagree with us—they're independent nations.

We just have to work with you on getting that funding up.

Admiral MCCARTHY. Just to expand on what Dr. Tunstall said, if you look at the numbers that you're dealing with in the six or so ships that are in the MCM and the numbers that we have in the MHC, you can see that we're making a dramatic improvement over where we were in the force structure before.

MH–53 capability in the mine hunter is coming very well. What we're also doing in that regard is to establish detection features within our combatants so that when they go in waters that are suspect as far as mines, they will in fact be able to detect them. That's a very unusual thing. We have not done that in the past and that's something new that will be there in the fleet.

In addition to that, there are a couple of special access programs that deal with this area.

Mr. HERTEL. I will be glad to talk about those in closed session. I thank you for that update. You're right, we are doing better than we've done before, because before it was no increase whatsoever. But we still need to be concerned about the poorest Third World nation as well as the terrorist groups in the future.

Even with what's now being done as improvements and additions, that would not be in any type of threat situation, obviously it would not be able to do the mission for our ships around the world at all. Again, we would be still relying on our Allies; and if they weren't with us, we would be in serious trouble once again.

Admiral, Mr. Secretary, General, all three of you, I want to thank you. We have some other questions for the record but since the rest of the subcommittee has had their opportunity already we will just submit those for the record.

I thank you all very much for your testimony and your frankness.

Mr. FAUGHT. Thank you very much.

Mr. HERTEL. The subcommittee will meet next Tuesday at 10 a.m.

[Whereupon, at 3:15 p.m., the subcommittee was recessed, to reconvene at 10 a.m., March 7, 1989.]

## ADVANCED SHIP DESIGN

Mr. Dellums: VADM Nyquist last week indicated to the Seapower Subcommittee that the DDG 51 ship hull would be used as an advanced "surface combatant" for a host of missions now performed by mixes of ships (i.e cruisers, destroyers, frigates, etc.) well into the 21st century. Does this mean we can tell our ship design community to go home for the next 20 years? What plans does the Navy have for advancing ship design and research?

Mr. Faught: Our ship design community is busier than ever. They are working on new designs and modified designs for many classes of surface ships including major upgrades to the DDG-51 and LHD 1 classes. In addition, there are studies ongoing which look at the surface ships of the future. Although our advanced ship design efforts have been curtailed recently by Congressional reductions in FY 88 and FY 89 we have continued to pursue advanced ship design concepts within the funding available. We are studying advanced hull forms such as SWATHs and ACVs and advanced systems such as integrated Electric Drive and Intercooled Recuperative Gas Turbine Engine.

## HUMAN FACTORS RESEARCH AND DEVELOPMENT

Mr. Dellums: What is the Navy's plan for human factors R&D to meet the demands of high technology equipment?

Mr. Faught: Navy policy is to maximize operational effectiveness of all new or modified systems by ensuring that they can be properly operated, maintained, and supported. Toward that end, the Navy supports an operations-oriented program of human factors R&D to improve fleet readiness by ensuring a better fit between operator, equipment, and mission.

The program's objectives are to reduce complexity while increasing automation, to increase system operability, to reduce training resource requirements, to improve information assimilation and tactical decision making, to reduce maintenance time, and to improve safety and damage control. Current efforts aimed at meeting those objectives focus on new techniques for system design, display and control technology, tactical decision aids, man-machine interface design, targeting technology, remote-operation technology, and crew performance assessment.

To ensure the application of findings from human factors R&D efforts, the Navy has structured its acquisition process to require consideration of the human capabilities and limitations of the forces that can be recruited, trained, and retained to operate Navy systems. For example, the Hardware/Manpower Integration (HARDMAN) program was implemented in FY 1986 to give the Navy improved analytical tools for determining the human implications of new weapon systems as they are designed. Although HARDMAN has not been applied consistently, we have taken steps to broaden its use and effectiveness. In addition, the Navy's Systems Commands require that human factors engineering be implemented in all ship systems, combat systems, and platform design beginning with program initiation.

The Navy is now drafting an instruction to implement DoD Directive 5000.53 of December 30, 1988, on Manpower, Personnel, Training, and Safety in the Defense System Acquisition Process. The aim will be to enhance total system performance by improving all aspects of the human-machine interface. The policy will apply to all new major systems, major modifications to existing systems,

and supporting simulators and training devices. Human-performance concepts, requirements, and goals must be developed consistently, communicated to industry in solicitation documents, evaluated in contract proposals, and evaluated as criteria for contractor selection. Through these and other measures the Navy will ensure operational effectiveness, economy, and consistency with constraints such as manpower structure, personnel aptitude and skill, human factors, training, safety, and logistics.

Faced by an increasingly sophisticated threat, declining rates of young people qualified and available for military service, more complex weapon systems, and tightening fiscal constraints, the Navy regards human factors R&D as a necessity, not an option. Plans for human factors R&D include the continued identification and funding of efforts in basic research, exploratory development, and advanced development that will contribute to system readiness and warfighting capability. The Navy is according these programs higher priority than in the past and is exploring options for increased funding, particularly in the area of tactical decision support and training (with emphasis on decision making under stress). Lessons learned both in the lab and in actual operations--most recently in the Persian Gulf--are being evaluated and applied to the design of future Navy systems. Our goal is a Navy that performs its mission more effectively and more safely with fewer people, lower training costs, and better damage control.

Mr. Dellums: The Navy "21 Study" points to many initiatives for the future and indicates that we will in essence be "replacing the current Navy with a new one." Does the Navy feel as though the current Science & Technology base (6.1 and 6.2) programs are structured to support this initiative? If not, what do you intend to do?

Mr. Faught: Yes, our research programs and technology mission areas cover each of the areas identified in the Navy 21 study. That study highlighted electronics, stealth/counter stealth, unmanned aerial/underwater vehicles, automation/robotics, and intelligent machines as key technologies, and supporting technolgies included the areas of propulsion, aeronautics, communication, information processing, laser/optical processors, and composite materials. Both the research programs of 6.1 and the technology mission areas of 6.2 very substantially support the technology objectives and requirements of Navy 21.

Mr. Dellums: What technologies in the 6.1 and 6.2 arena do you feel will have the most pay-off for the future and can you describe in any detail the organizations, technical leaders and support you are giving them to ensure successful development?

Mr. Faught: I have recently completed an examination of the technologies critical to the future Navy and Marine Corps. With the diversity of the naval mission and the complexity of modern technology, it is not possible to focus on just a handful of key technologies as the solution to the problems we will be facing as we enter the 21st century. Our list of essential high-payoff technology areas and sub-technologies is provided in the accompanying table. I will highlight a few of those in the discussion that follows.

First, however, I would like to address the second part of your question. I consider the technology base (6.1/6.2) account to be an absolutely critical corporate account. I am able to ensure the visibility and integrity of the DoN's technology base program because the manager of this program, the Chief of Naval Research, reports directly to me. Through the CNR's co-located Offices of

Naval Research (6.1) and Naval Technology (6.2), the Department is able to provide the best possible conduit for communication of Navy requirements to R&D efforts; manage coordinated simultaneous pursuit of science and technology development performed at universities, government labs, and industry; and provide rapid transition of innovative R&D results into Navy development programs and operational systems.

Now let me elaborate on nine of our high-payoff technologies:

Ocean and Atmospheric Measurement and Prediction: It is becoming increasingly important to gather and predict the environmental conditions in which weapon systems perform. This is particularly true for target detection and tracking systems both in the atmosphere and underwater. Applications of low observables technology are making targets, whether they be aircraft, missiles, submarines, or torpedoes, increasingly difficult to acquire and track. This technology provides a growing understanding of the environmental factors, such as weather, ionospheric conditions, ocean temperatures, etc., which affect operations of our forces and their weapons. An aggressive and multifaceted R&D program is pursuing this technology in a wide variety of areas and organizations. Projects are emphasized in acoustic transients, reverberation, and tomography; air-sea interaction; Arctic acoustics and oceanography; environmental modelling and prediction; remote sensing; ocean wave processes, and others. Leadership is provided by Navy laboratories like NORDA, NOSC and NEPRF, by the Navy-owned university-operated fleet of research vessels, and by university ocean aciences programs across the nation. The total 6.1N and 6.2N investment in this technology is in excess of $130M in FY89.

High-Strength Light-Weight Materials and Processing: This array of technologies is producing the advanced materials necessary for the design and manufacture of present and future military systems. New materials, their manufacture, and their application to and incorporation in military equipment, involve technologies of composites, polymers, high-temperature materials, etc., as well as new manufacturing technologies for forming, fabricating, and coating, both of conventional and novel materials. Technologies include super alloy development, rapid solidification technology, thick section composites for submarine hulls, epoxy-matrix and metal matrix technology, advanced fiber technology (especially graphite fibers), and fiber/matrix interface technologies. Coatings technology, particularly that used for corrosion resistance, is also of great importance to military applications. Materials technology will impact virtually every new weapon system. It will be required across a wide spectrum of vehicle structures, such as high-temperature propulsion systems, hypervelocity vehicles, STOL and VTOL vehicles, as well as coatings for spacecraft, protection against directed energy threats, and advanced hull forms and submarine structures. Next-generation materials and structures will emphasize additional multifunction capabilities where sensors and countermeasures will be integrated, resulting in options for military systems which are unheard of today. ONR and ONT sponsored research and development are being performed in many organizations, notably by University of California at Santa Barbara, Drexel University, Cornell University, Brown University, Penn State University, Case Western Reserve University, Rensselaer Polytech Institute, Massachusetts Institute of Technology, the Lanxide Corporation, and the United Technologies Research Center. The program funding for fiscal 1989 was over $53 million.

Blood Surrogate: Development of a surrogate blood that can be used in battlefield situations to resuscitate casualties is reaching maturity. Surrogate blood consists of hemoglobin that is encapsulated in artificial cells called liposomes. This synthetic blood can be stored in concentrated solutions at room temperatures for months, thereby greatly simplifying the logistical burden associated with regular blood. It can also be given without blood typing (universal donor); hence, transfusions can be done quickly and improve chances for survival. It also has the advantage of being free from AIDS or hepatitis virus contamination. This technology will save battle casualties and multitudes of civilian lives. Development is being pursued at the Naval Research Laboratory, Tulane University, University of Texas and the Uniformed Services University of Health Sciences.

High Performance Explosives and Propellants: A recent breakthrough in explosive technology has resulted in synthesis of a new higher-energy, insensitive explosive called CL-20. Cooperative DOD/DOE, interservice exploitation of CL-20 is establishing CL-20 enabling technology for: low observable, high performance, lighter, less sensitive missile propellants; high impetus, low vulnerability gun propellants; and high performance shaped charges. Sponsored R&D in this technology is led by the University of California, Berkeley, Naval Weapons Center and University of Chicago. The program funding for 1989 was $6M.

Long Wavelength Infrared Search and Track: The application of low observables technology to aircraft and missiles make targets increasingly difficult to acquire and track. In addition, protection of our own forces requires passive sensors which do not disclose the position of the surveillance platform. Long wavelength IR represents a residual signature, in any vehicle aerodynamically heated, even when designed for stealth. Technology is being developed to solve the problems inherent in separating the radiant IR signals of targets from the naturally occurring IR sources in the environment to support the development of IRST systems to meet the reduced observable threat. The Navy is addressing technology in multi-line low noise sensors employing focal plane array detectors, clutter rejection algorithims to reduce the false alarm rate and multi-sensor. In addition, a more basic study had been undertaken to analyze and model the background clutter sources and propagation losses which limit the effectiveness of current IR systems. This effort will define the ultimate utility of IR sensors in a maritime environment. Results of these long wave IRST efforts are supporting ongoing Navy development programs for Navy fighter aircraft, shipboard and space borne platforms. The program funding for this area in FY89 is about $10M.

Superconducting Electronics: To meet current and future threats to the Fleet, the importance of active and passive systems with greater sensitivity, higher throughput rates, and wider bandwidths is increasing. The high speed, low noise, and low power properties of superconducting devices provide the potential for these needs to be met while the use of the recently discovered high temperature superconductors can make these systems considerably more energy and cost efficient. The Navy is implementing a mutli-faceted program in superconducting electronics with an emphasis on applications to communications and surveillance. Using low Tc superconductors, a quantum-limited magnetic field detection system for ASW and buried mine detection is under development at the Naval Coastal Systems Center. High frequency antennas

and low noise receivers for operation in the UHF through the millimeter wave region are being developed at NRL, NWC, and NOSC while very high speed signal processing circuits and systems are under study by ONR contractors and at several Navy laboratories and centers. There are also large efforts underway within the Navy to exploit the recently discovered high temperature superconducting materials. Once these materials are engineered into useful technological form, superconducting circuit elements such as transmission lines and active devices can be integrated with other technologies, such as low temperature CMOS, to realize very high speed, low power processors which will revolutionize Naval surveillance and communications systems. The total 6.1 and 6.2 investment in developing both low temperature superconducting electronic technology and high temperature for FY-89 is about $10M of the total $30M DoD investment in this area.

Acoustic Array Signal Processing: Maintaining our lead in computer and signal processing is vital to our success in almost every warfare area. This is particularly true in the ASW arena where recent advances in signal processing are opening vast new opportunities. Only a few years ago, our systems were severely limited by the amount of processing power we could employ to sort acoustic signals from the ocean background noise. This limited the number of sensors that could be reasonably employed, as a practical matter, which in turn limited achievable system gain and resolution. Today with the advent of new technologies such as parallel processing and the construction of ultra fast machines, we are able to apply new approaches to process information from relatively large numbers of acoustic sensors. Applied successfully, this means that we will be able to detect lower level signal sources than ever before -- an essential ingredient in providing our ASW forces with the improved systems necessary to cope with the quieter submarine threats expected in the future. The Navy is aggressively pursuing a full spectrum of programs, from the development of improved processors and architectures to their practical application in the solution of problems in advanced acoustic systems, to ensure that we will not fall behind in this key area. This effort is being led by Navy laboratories such as NOSC, NUSC, NRL and NORDA in cooperation with both industry and the academic community. The program funding for this area in FY89 is about $12M.

Large Aperture, High Gain Acoustic Arrays: Soviet submarines have demonstrated significant quieting in recent years and are expected to continue this trend in the future. These developments have already impacted the effectiveness of U.S. ASW forces and systems and underscore the need for a quantum step forward in acoustic detection systems. In particular, the effectiveness of fixed, long range passive surveillance systems has, in the past, provided the U.S. Navy with a clear advantage in ASW operations. It is essential to the maintenance of an effective ASW force that a significant improvement in signal to noise gain be achieved for these key systems. Recent work indicates that large aperture, high gain to acoustic arrays may have potential for achieving the necessary gain to offset projected Soviet submarine quieting. Under the Office of Naval Technology (ONT), the High Gain Initiative Program is currently investigating the science and emerging technologies associated with such large acoustic arrays. The program involves an ambitious schedule of at-sea experiments combined with analytical investigations and focuses on developing a detailed, end-to-end system simulation. The

program is also developing advanced signal processing techniques to support system concepts involving extremely large numbers of acoustic sensors. Major participants in this 6.2 program include ONR, NOSC, NRL, NORDA, the Marine Pysical Laboratory (MPL), and various defense contractors. To date, ONT has invested over $20M in the High Gain Intiative Program and has budgeted over $47M during the next five years.

Underwater Closed-Cycle Propulsion: The recognized increased performance capabilities of threat submarines place significant new demands on our ASW weapons. A major innovative step for torpedoes is in the development of technology for a very high power and energy density, Stored Chemical Energy Closed-Cycle Propulsion System (SCEPS). The substantially increased power/energy density provides torpedoes speed/endurance required to attack a high speed, evading submarine at long range in complex tactical scenarios. The closed-cycle system permits depth - independent performance at reduced noise to avoid target alert. The initial application of the SCEPS technology is the MK 50 torpedo, the Navy's future air-delivered ASW weapon. Subsequent technology efforts, termed ADvanced SCEPS, are being applied to the Submarine-launched torpedo, as well as future upgrades of the MK 50 through its $P^3I$. Further, the ADSCEPS technology is filling a critical weapons T&E need for a full speed/depth capable, underwater artificial target. The future focus under the Navy's Advance Torpedo Technology Thrust is on extremely long endurance, low noise missions and compactness for reduced-size weapons. Approximately $18M of 6.2 funding has been invested in this high leverage technology. The Applied Research Laboratory, Penn State University is the principal performer with considerable contribution made by several industrial sources.

TECHNOLOGIES CRITICAL TO THE PROGRESS,EFFECTIVENESS AND SECURITY OF FUTURE U.S. NAVY FORCES

- ACOUSTICS
  - High Gain Arrays
  - Low Frequency Active Sonars
  - Structural Acoustics
  - Transducers
- ADVANCED MICROELECTRONICS
  - Microelectronic Circuit Fabrication
  - Molecular Beam Epitaxy
  - Ultrasubmicron Silicon
  - Gallium-Arsenide and other compound Semiconductors
- ADVANCED MATERIALS AND STRUCTURES
  - Ceramics
  - Composites
  - Coatings
  - Electronic Materials
  - Energetic Materials
  - Energy Absorbing Materials
  - High temperature/strength, lightweight Materials
  - Material Joining
- ADVANCED OPTICAL TECHNOLOGY
  - Integrated Optics
  - Mirrors
  - Optical coatings
  - Optical Processing
  - Photonics
- BIOTECHNOLOGY
  - Blood Substitutes
  - Lithography Techniques

- Marine Materials and Adhesives
- Wound Healing

- DIRECTED ENERGY
  - Adaptive Optics
  - Charged Particle Beam
  - High Power Lasers
  - Microwave
  - Directional Warheads
- ELECTRO-OPTICS
  - Fiber Optic Sensors
  - Infrared Detectors
  - Narrow Band Filters
  - Ultra Low-loss Fiber Optic Cables
- HUMAN FACTORS AND TRAINING
  - Cognition
  - Decision Aids
  - Decision making under combat stress
  - Diagnostics
  - Man-Machine Interface
- HYDRODYNAMICS AND CONTROL
  - Active-Adaptive Control
  - Computational Fluid Dynamics
  - Drag Reduction
  - Hull-Appendage Interaction
  - Non-Linear Dynamics
  - Wake reduction
- INFORMATION TECHNOLOGY
  - Artificial Intelligence
  - Communications Networking
  - Data Fusion
  - Neural Networks
  - Parallel Processing
  - Signal Processing
  - Software Engineering
  - Supercomputers
- LASERS
  - Chemical
  - Free Electron
  - Solid State
- OCEAN SCIENCES
  - Acoustic Tomography
  - Altimeters
  - Environmental Acoustics
  - Ocean and Atmospheric Modeling and Model Integration
  - Ocean Optics
  - Scatterometers
- POWER SOURCES
  - Batteries
  - Fuel Cells
  - Hydrothermal vents
  - Pulsed Power
- PROPULSION TECHNOLOGY
  - Air Breathing
  - Closed Cycle
  - Electric Drive
  - Nuclear
  - Propulsors
- RADAR TECHNOLOGY
  - Advanced Waveforms
  - Microwave/Milimeter wave Integrated Circuits

- Microwave Tubes
- Phased Arrays
- Synthetic Aperture/Inverse Synthetic Aperture Radars

- SUPERCONDUCTIVITY
  - Electronics
  - High Tc Materials
  - Magnetometers
  - Propulsion
  - Thin Film

Oceanographic Programs

Mr. Dellums: Two areas of concern that will have impact on our future sonar systems and laser communications systems are ocean environmental acoustics and ocean optics respectively. Can you tell me what the Navy oceanographic programs are about, with emphasis on these two areas?

Mr. Faught: The overall purpose of the Navy's oceanographic program is to develop a fundamental understanding of the Navy's operating environment, and to exploit this knowledge base to achieve tactical and strategic advantages. We are pursuing this goal by conducting programs which include basic research, exploratory and advanced development, and operational surveys to define the limits imposed by the environment on sensor and weapon system performance; by development of environmental and performance prediction models which allow optimum employment of ships, aircraft and weapons; and by assessment of the effects of the environment on new system concepts. The Navy's research and development technology base program is managed by the Chief of Naval Research and the Oceanographer of the Navy manages the advanced development and operational oceanography program.

In the area of sonar system, the Navy sponsors programs ranging from basic research through operational surveys in forward ASW operation of current and proposed ASW surveillance, tactical and weapons systems. Performance modeling of ASW systems and characterization of the ocean-acoustic environment provide information to assess the environment's impact on new generation systems. These programs are addressing the ocean-acoustic concerns of numerous new generation sonar systems, including: Very Low Frequency (VLF) sonobuoys, Fixed Distributed Systems (FDS) and surveillance and tactical Low Frequency Active (LFA) systems. Efforts include measurements and modeling of ambient noise, reverberation, acoustic propagation, ocean fronts and eddies, sound speed structure, bathymetry and geophysical properties. Emphasis is being placed on provision of a tactical oceanography capability which will combine satellite remote sensing, oceanographic forecasting and three-dimensional acoustic modeling to provide tactical decision aids for use by the tactical commander to predict sonar system performance in real-time.

The Navy's ocean optics program has significant emphasis in basic research and advanced development that support laser communication and non-acoustic ASW systems. Research and development efforts focus on development of the predictive capability through which optical characteristics of ocean water can be extrapolated from primary environmental information. Development of the technical base for naval applications of optical systems includes simultaneous laboratory measurements, instrument development and field studies; development of predictive models,

data bases and measurement techniques to support operational employment of optical systems; development of water clarity atlases; determination of the relationship of water clarify to spaced-sensed ocean color; and support to advanced development systems.

Supporting these R&D efforts the Naval Oceanographic Office conducts operational surveys and maintains data bases of oceanographic conditions. In accomplishing its mission, the Navy currently owns 19 Oceanographic ships, 12 operated by universities, three specially configured aircraft, and will soon install a Class VII Large Scale Computer at the Naval Oceanographic Office.

NAVY SPONSORED UNIVERSITY LABORATORIES

Mr. Dellums: The Navy has four captive laboratories (ARL/PSU, ARL/UT, APL/JHU, APL/UW). Can you tell me what their budget figures (6.1, 6.2 and 6.3) are? What particular benefit is derived from this "captive laboratory" situation that can't be done in your existing laboratory structure?

Mr. Faught:

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| | 6.1 | 6.2 | 6.3 |
|---|---|---|---|
| ARL/PSU | $700 | $12,000 | $12,400 |
| ARL/UT | 951 | 1,677 | 11,267 |
| ARL/JHU | 1,088 * | 3,274 * | 91,167 * |
| APL/UW | 9,100 | 3,300 | 2,300 |

*Navy funding only
**Latest available funding

The four Navy sponsored university laboratories perform research and development (R&D) for the Navy in a role that is similar to the Navy's own R&D Centers. Although these laboratories are not Government-owned, they are considered a part of the Navy's existing laboratory structure and have capabilities that complement the Navy Centers in providing independent technical advice and evaluation to the Navy. Examples include the Trident submarine security work performed by JHU/APL, arctic research and development and related support by APL/UW, undersea weapons guidance and control technology at ARL/PSU, and capabilities in integrated undersea surveillance at ARL/UT.

The university laboratories provide many technical capabilities that are not currently available at the Navy R&D Centers. While some capabilities could be transitioned to the Centers, such changes would generally not be advantageous to the Navy. The Navy Centers are currently contracting out about half of their program work, partly because they don't have adequate resources to perform more in-house. Transitioning work from the university laboratories to the Navy R&D Centers would be costly and disruptive, and would displace other work currently on-going at the Navy Centers.

The university laboratories also have an academic linkage which is important because it attracts U.S. students into technical fields that are of special interest to the Navy. An example of this is the special academic program in underwater acoustics at the Pennsylvania State University (PSU), which is

dependent upon the interaction with related Navy programs on-going at PSU's Applied Research Laboratory.

For over forty-five years, these university laboratories have been an effective and economical means for the Navy to obtain critical technical support. It is important that the present working relationship between these university laboratories and the Navy be retained.

## NUCLEAR DEPTH BOMB

Mr. Dellums: Please describe your Nuclear Depth Bomb program and why you believe it has been not always received Congressional support. Also, please describe the Sea Lance nuclear warhead study effort.

Mr. Faught: The nuclear depth bomb is a warhead/playload for the Sea Lance ASW Standoff Weapon. It provides a hedge against Soviet improved DELETED technological surprises as well as provides a larger area of kill compared to conventional warheads. DELETED

A CNO decision was made in January 1988 to continue development of the nuclear depth bomb for Sea Lance but not at the expense of the conventional variant. As a result of combining Vertical Launch ASROC and Sea Lance an employment effectiveness study is being conducted this year. Initial program estimates for Design Definition and Full Scale Engineering Development are six years at a cost of $250M, based on the mature Sea Lance missile development.

## LARGE SCALE VEHICLE

Mr. Dellums: The Navy has invested $100 million plus in the large scale vehicle (LSV) for propulsor testing of the SSN-21 which will end at the end of FY 90 or so. What happens to that asset? I understand that it takes about $10 million/year to run, care and feed. Who pays for that? I hope that unique vehicle, which is the world's largest autonomous vehicle can be used to advance autonomous technology at least, if not be used for other experiments.

Mr. Faught: The large scale vehicle (LSV) is a major national asset for submarine research and development. It provides the Navy with unique intermediate, between small scale models testing and full size, test capabilities which are used to validate computer predictions. The care and feeding of the system is supported through user funding at a level of approximately $3M per year. The vehicle has been used for propulsor development, new materials testing, hydrodynamics modifications for fairwaters and fillets testing, composite materials, and control surfaces. It's future utilization will include the above areas as well as energy storage/sources, coatings to reduce drag and acoustic materials, guidance control and navigation for unmanned underwater vehicles, propulsor drive train quieting materials and techniques.

## SHIP R&D

Mr. Dellums: The U.S. is a maritime nation. But with the recent lull in U.S. shipbuilding activity, it is more important to have a strong ship related R&D program in the Navy. Why isn't

the Navy serious about Ship R&D. (I don't call under $15 million (.015% of TOA) serious ship R&D.) Certainly there is a case for dual-use technology development?

Mr. Faught: The Navy is very serious about ship R&D. The total ship related R&D is approximately $100 million per year. The accounts (PE0603508N, PE0603513N, PE0603564N, PE0603573N, and PE0604567N) have been dropping off to a low of $79 million in 1988. However, the 1989 budget for these lines is back up to $100 million with a steady increase in the President's budget for 1990 and the outyears. It should be noted that Congressional cuts in 1988 and 1989 to PE0603564N have severely restricted our efforts to conduct advanced ship designs.

## HIGH STRENGTH LOW ALLOY STEELS

Mr. Dellums: I understand that the Navy has invested successfully over $10 million in the high strength low alloy (HSLA) steels which results in substantial ship construction costs savings. What is the status of your commitment to HSLA for ship and submarines? Is your commitment reflected in your development program?

Mr. Faught: HSLA is certified for structural and ballistic applications in surface ships. We currently have HSLA specified in many of our ship programs. These include the CG-47, DDG-51, LHD and CVN. In fact, HSLA is the material of choice for high strength applications in all future surface ships. The only reservation is HSLA 100's use as crack arresters. HSLA 100 will be certified for this application when the need arises. Submarine applications of HSLA material for non-pressure hulls and foundations are under consideration. Future utilization of higher strengths HSLA (i.e. HSLA 130) will be initiated when the need arises for a specific ship of system application.

## NATIONAL SHIPBUILDING RESEARCH PROGRAM

Mr. Dellums: I understand that since 1986 the Maritime Administration R&D budget has not included funds for the National Shipbuilding Research Program (NSRP--A cooperative government/industry program) and that a cost benefit study was conducted by ASN(S&L) showed large potential return on a Navy investment to NSRP for future acquisition and modernization. Would you please share your views?

Mr. Faught: A study of costs and benefits of the National Shipbuilding Research Program was performed by the Naval Sea Systems Command for the Assistant Secretary of the Navy for Shipbuilding and Logistics in November 1986. This study showed that the Maritime Administration sponsored the program from 1971 through 1985 and applied $39.6 million in funds over this 15 year time period. The Navy began also sponsoring the program in 1982 and applied $7.2 million in funds from 1982 through 1985. From 1971 through 1985, industry applied $17 million in this cooperative government and industry program. This study identified almost $200 million in production cost savings attributed to naval shipbuilding programs alone at just five shipyards that could be examined during the study. Additional savings were projected for other naval shipbuilding and naval ship repair programs. The National Shipbuilding Research Program has a very favorable return on investment. Very modest annual research investments in shipbuilding

technology yield improved methods, processes, and equipment that have lasting cost reduction benefits in ship production programs.

Mr. Dellums: The Navy's 6.1, 6.2 portion of RDT&E (where there's more R than D) is less than 8 percent of the RDT&E budget and less than 1 percent of the total TOA. How does this compare with the 60s and 70s? (Typically about 1/2 percent of TOA.) Seems as though we don't believe in Research. I'm sure industry makes higher R&D (6.1, 6.2 like) investments.

Mr. Faught:

| FY | 6.1 ($M) | 6.2 ($M) | TECHBASE ($M) | NAVY RDT&E ($B) | NAVY TOA ($B) | TB AS % OF RDT&EN | TB AS % OF NAVY TOA |
|---|---|---|---|---|---|---|---|
| 65 | 122.073 | 349.333 | 471.406 | 1.423366 | 14.856 | 33.1 | 3.2 |
| 66 | 123.335 | 321.458 | 444.793 | 1.582457 | 19.185 | 28.1 | 2.3 |
| 67 | 131.213 | 290.463 | 421.676 | 1.947422 | 21.190 | 21.7 | 2.0 |
| 68 | 124.382 | 260.809 | 385.191 | 1.886250 | 20.781 | 20.4 | 1.9 |
| 69 | 130.312 | 262.067 | 392.379 | 2.191541 | 21.552 | 17.9 | 1.8 |
| 70 | 117.828 | 238.127 | 355.955 | 2.271919 | 22.462 | 15.7 | 1.6 |
| 71 | 114.611 | 239.334 | 353.945 | 2.211001 | 21.691 | 16.0 | 1.6 |
| 72 | 124.601 | 281.809 | 406.410 | 2.411109 | 24.041 | 16.9 | 1.7 |
| 73 | 112.690 | 273.658 | 386.348 | 2.541604 | 25.324 | 15.2 | 1.5 |
| 74 | 114.194 | 278.137 | 401.331 | 2.704473 | 26.934 | 14.8 | 1.5 |
| 75 | 118.702 | 287.789 | 406.491 | 3.051614 | 27.962 | 13.3 | 1.5 |
| 76 | 129.673 | 308.277 | 437.950 | 3.314320 | 31.360 | 13.2 | 1.4 |
| 77 | 153.769 | 343.593 | 497.362 | 3.800055 | 37.353 | 13.1 | 1.3 |
| 78 | 172.088 | 354.229 | 526.317 | 4.054309 | 39.504 | 13.0 | 1.3 |
| 79 | 192.122 | 375.193 | 567.315 | 4.464380 | 41.694 | 12.7 | 1.4 |
| 80 | 214.941 | 396.207 | 611.148 | 4.563270 | 46.984 | 13.4 | 1.3 |
| 81 | 241.418 | 461.328 | 702.746 | 5.024866 | 57.050 | 14.0 | 1.2 |
| 82 | 276.524 | 494.365 | 770.889 | 5.834626 | 68.607 | 13.2 | 1.1 |
| 83 | 307.640 | 525.514 | 833.154 | 6.100131 | 81.289 | 13.7 | 1.0 |
| 84 | 319.179 | 446.294 | 765.473 | 7.629418 | 81.706 | 10.0 | 0.9 |
| 85 | 340.246 | 451.154 | 791.400 | 9.070906 | 95.544 | 8.7 | 0.8 |
| 86 | 342.209 | 443.664 | 785.873 | 9.520864 | 93.834 | 8.3 | 0.8 |
| 87 | 354.307 | 434.710 | 789.017 | 9.352928 | 94.802 | 8.4 | 0.8 |
| 88 | 339.247 | 407.419 | 746.666 | 9.478546 | 102.363 | 7.9 | 0.7 |
| 89 | 355.304 | 431.166 | 786.470 | 9.344589 | 98.247 | 8.4 | 0.8 |

STRATEGIC RDT&E

Mr. Dellums: Why did the strategic RDT&E budget double from 7 to 14 percent per page 8 of the ASN(RE&S) statement?

Mr. Faught: The increase shown out to the year 2005 anticipates the development of a follow-on to the TRIDENT II D-5 missile starting in the late 1990s. While there currently is no official requirement for such a follow-on Sea-Launched Ballistic Missile, history suggests and prudence dictates that our long range R&D planning include the substantial costs of such a development.

TOMAHAWK

Mr. Dellums: What current mission now performed by aircraft or other forces could be performed better with the use of an advanced TOMAHAWK (zero CEP)? Is this a less costly alternative to manned aircraft?

Mr. Faught: While sea launched conventional cruise missiles are intended to complement manned aircraft in the execution of

strike missions, there are several special situations where use of a cruise missile on a "stand alone" basis may be preferred.

[deleted]

HFAJ

Mr. Dellums: In the Navy 21 Study, Navy identified that anti-jam communications is a high priority. The Navy has told the Committee in the past that the HFAJ program was being terminated due to non-affordability. Also, that if the results of the Phase I effort, which was continued with FY-88 funding should identify a more affordable program, the Navy would consider reinstatement of HFAJ because the requirement for the anti-jam HF was still valid. We understand that the Navy has been briefed by the contractor team that an HFAJ capability could be implemented for over $2 Billion less than originally estimated. In light of this significant cost reduction how will the Navy proceed with HFAJ?

Mr. Faught: The Navy 21 Study was instituted to look at the year 2030 and determine technologies to pursue, it was not intended as a vehicle to make near term acquisition management decisions. Many aspects of this study will be under review for a long time.

HFAJ was terminated due to non-affordability, as stated. Subsequently, an unsolicited contractor presentation on HFAJ that is linked to a proposed Multi-media Link-11 Program has been presented to Navy with a total cost estimate between $1.4B and $3.8B (this cost estimate is not verified and was provided by the contractor using FY-86 dollars). A review of both the Multi-media Link-11 Program and HFAJ proposals is actively in progress. The results of earlier studies conducted by the Joint Venture Team of Rockwell-Marconi under Phase 1 of the HFAJ program will be available to the systems command in June or July. Following analysis of the Phase 1 Study results Navy will have a clearer picture of its HF communications requirements for the future. The ultimate plan is not yet clear, but we expect to have more definitive answers by the end of August. At present HFAJ remains unaffordable.

Mr. Dellums: As the largest user of HF communications, shouldn't the Navy be leading the effort to provide anti-jam HF for all of DoD?

Mr. Faught: OSD currently has the action to develop a joint program for standards, equipment development and qualification. Until Navy firmly establishes its method of communications and its requirements for the future, we are not prepared to lead any DoD HF program. Even if desired, HFAJ may still be an unaffordable program.

Mr. Dellums: Should HFAJ be a jointly funded program with the Navy as lead?

Mr. Faught: This would be an OSD issue regarding the necessity of a joint program.

Mr. Dellums: The HFAJ program was started to provide modern HF communication capability for the fleet in addition to having anti-jam capability. Assuming the new construction and overhauled platforms will continue to need HF communications, what programs are presently planned and are these costs being considered as a potential offset to the costs estimated for the HFAJ program.

Mr. Faught: Regarding modernization of existing and future installations, Navy is taking steps to re-equip the Fleet. The AN/FRT-96 ten kilowatt transmitter is replacing shorebased

narrowband HF equipment. Acquisition plans are in place for the next generation narrowband HF equipment afloat. Navy is reviewing requirements for the next generation couplers. The AN/USQ-83 HF MODEM (modulator/demodulator) has successfully completed OPEVAL and Navy is formulating plans for its implementation. The AN/URC-109, under evaluation on LHD-1, may be used in new construction and service life extension programs. The current plans for communications equipment implementation fulfill the need to provide a modern HF communication capability and as such are part of the overall resource outlay envisioned under the original concept. These costs, therefore, cannot be considered as offsets since they are part of any follow-on component of the program.

Mr. Dellums: The Navy has stated that its primary communication anti-jam programs are JTIDS, MILSTAR, HAVEQUICK and SINCGARS. None of these can communicate beyond the line of sight without being relayed. Furthermore, not all naval platforms will have these anti-jam capabilities. We also understand the primary medium used for Naval Tactical Data Systems (NTDS) Link-11 in a battle force is HF. Without HFAJ capability, how will the Navy be able to use Link-11 in a jammed environment?

Mr. Faught: The established priorities satisfy Joint and individual service information passing requirements.

The Multi-media Link-11 program review will determine the course of Navy's improved link concepts and the HF "road map" available in August of this year will provide HF communication specific information.

Whichever course is chosen, Navy will design connectivity under approved concepts of operations to fulfill Joint and NATO connectivity requirements.

Example of alternatives and possibilities include Link-11 improvements with: satellite EHF, Single Channel Ground Air Radio, HAVEQUICK UHF and Multi-media communications (with or without HFAJ).

Navy recognizes the need for reliable, secure, jam-resistant communications, and we are in the process of evaluating our options. Cost is the driver.

# DEPARTMENT OF AIR FORCE RDT&E BUDGET FOR 1990

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Tuesday, March 7, 1989.*

The subcommittee met pursuant to call, at 1:30 p.m., in room 2118, Rayburn House Office Building, Hon. Ronald Dellums (chairman of the subcommittee) presiding.

## STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The subcommittee will come to order.

Today the subcommittee will continue its hearings on the fiscal year 1990 budget.

The Department of the Air Force budget for research and development is the largest of the three service budgets. This fact is exemplified by the fact that the Air Force budget is more than twice that of the Department of the Army. It is difficult in a short period of time, such as these hearings, to review in any measure of detail, the multitude of programs supported by a request of over $14 billion. We are further frustrated in that the budget before the subcommittee is not the final budget. President Bush's budget is still being worked on in the Pentagon and is not expected to be available until some time in April. Realizing these constraints, I hope that the witnesses can be as far sighted and flexible in their testimony as possible so that the subcommittee can get a good idea of what programs are contained in this request.

The Air Force research and development budget offers a further constraint since a large portion of the budget is allocated to special access programs such as the B–2 bomber and the Advanced Tactical Fighter programs. We are holding separate hearings on these two programs so it won't be necessary to go into them in detail in today's presentation. However, an example of a large program which is not in the special access category nor one that we will hold a separate hearing on is the National Aero-Space Plane. I am sure the members of the subcommittee will be very interested in being updated on the status of this program.

Today we welcome before the subcommittee the Honorable John J. Welch, Jr., Assistant Secretary of the Air Force for Acquisition and Lt. Gen. Ronald W. Yates, Director, Tactical Programs for the Air Force who has just recently been promoted.

Since we don't have our ranking minority member with us at the present time and without any objection, the Chair would yield to

our distinguished witnesses to proceed in any fashion that they choose and without objection, the entire text of your testimony will be presented at the appropriate place in the record.

Please proceed.

**STATEMENT OF HONORABLE JOHN J. WELCH, JR. ASSISTANT SECRETARY OF ACQUISITION, DEPARTMENT OF THE AIR FORCE**

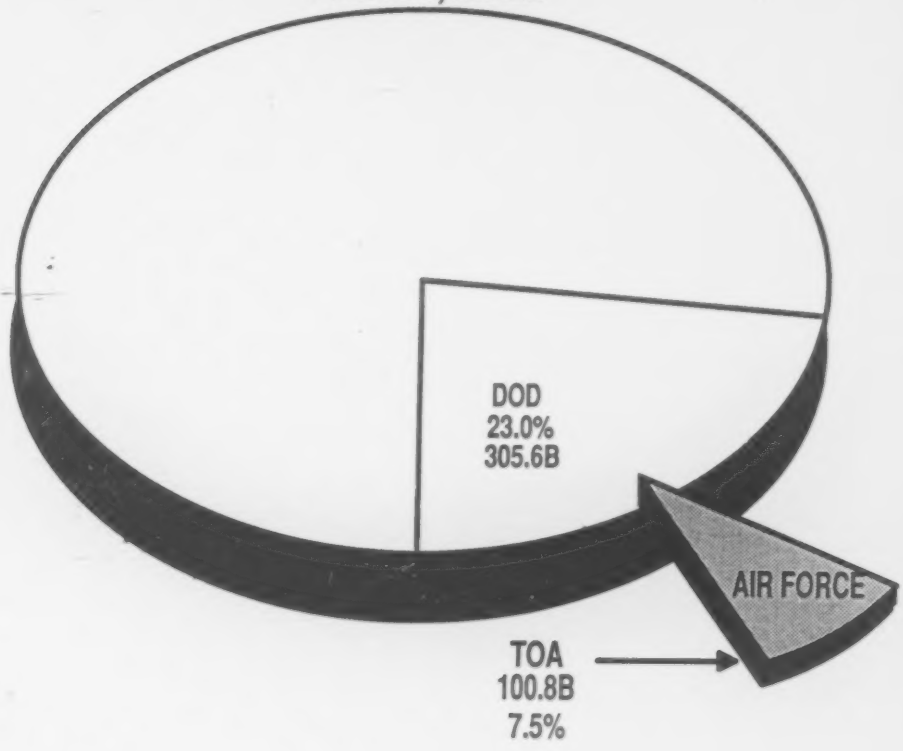
Mr. WELCH. Thank you Mr. Chairman, members of the committee. We are pleased to appear here, today. We will divide this into two segments with your permission, much as we would have had there been a morning and afternoon session.

We would thank you for the request to present in a different format today and we will start with the RTD&E process, that we use in the Air Force. We have also changed from ubiquitous view graphs to charts which each of you has in front of you to aid in following the process. I will begin by describing the Air Force budget. As you pointed out in the RTD&E area is the largest of the services, and I would like to show you how we do this. We will cover a part of science and technology acquisition and then I will ask General Yates to complete the first segment of the briefing in how it comes into existence and how through the research and development process it ends up ready for production. We will be dealing in some specifics.

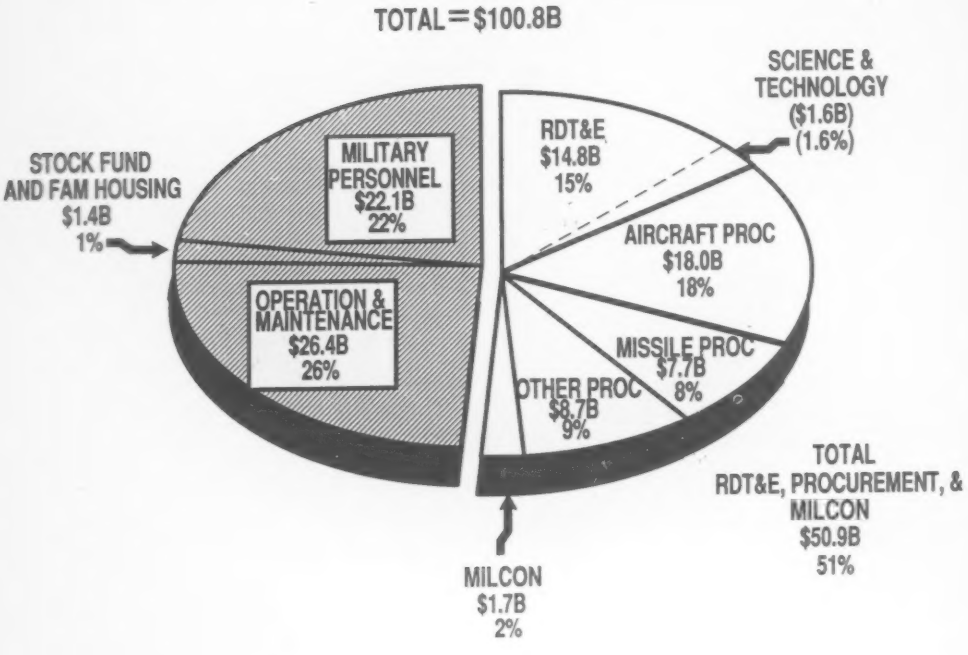
We will try to tie how science and technology feeds specifically into the programs that we later see in development and in production. At that point I would suggest that we stop and discuss the science and technology issues and then we will start into a second segment at which time we would go into the development to production part of the process. We will discuss specific road maps and specific programs. I believe that will tie the package together.

# FISCAL YEAR 1990
# FEDERAL BUDGET AUTHORITY REQUEST

TOTAL 1,331.2B



## USAF FISCAL YEAR 1990 BUDGET REQUEST BY APPROPRIATION


TOTAL = $100.8B
SCIENCE & TECHNOLOGY ($1.6B) (1.6%)
RDT&E $14.8B 15%
STOCK FUND AND FAM HOUSING $1.4B 1%
MILITARY PERSONNEL $22.1B 22%
AIRCRAFT PROC $18.0B 18%
OPERATION & MAINTENANCE $26.4B 26%
MISSILE PROC $7.7B 8%
OTHER PROC $8.7B 9%
TOTAL RDT&E, PROCUREMENT, & MILCON $50.9B 51%
MILCON $1.7B 2%

In the first tab of your book, in quick overview, it is pointed out that we do have a $1.3 trillion Federal budget. The Air Force portion is about $100 billion or 7.5 percent of that total. The second tab shows that $14.8 billion Air Force budget or 15 percent of the Federal budget. S&T is about $1.6 billion or 1.6 percent of the Air Force budget. There has been a decline from fiscal 1989 to fiscal 1990 of a small amount. You will note that the total RDT&E and Procurement budget represents about half of the total Air Force budget.

# RDT&E
## USAF FISCAL YEAR 1990 BUDGET REQUEST
## TOTAL: $14.8B

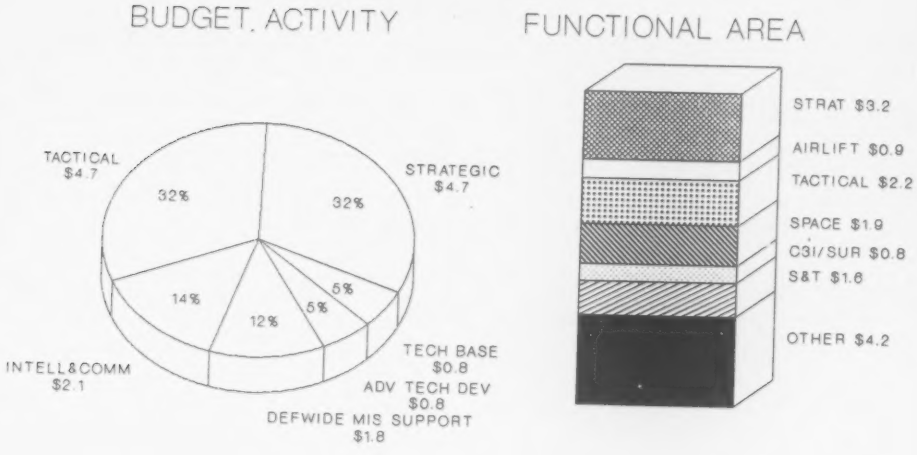



Chart three shows how research and development is divided somewhat differently for budgeting purposes than the way the Air Force plans, which is by mission areas. Note that space, for example, is not on the left side of that pie chart. That is because for budgeting purposes it is absorbed in the mission area it supports and in this case it is several mission areas; communications, tactical and strategic slices of the pie.

But this should provide you an opportunity to compare our mission areas and our budgeting process.

# FY 1990 AIR FORCE BUDGET PRIORITIES

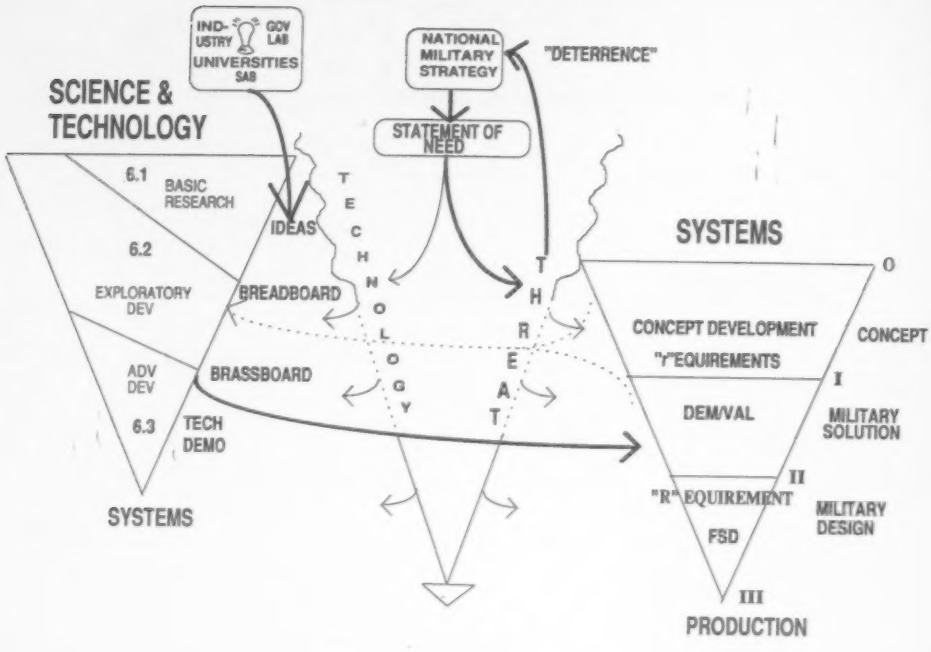
- MODERNIZE STRATEGIC FORCES (OFFENSIVE AND DEFENSIVE)
- MAINTAIN HIGH LEVEL OF READINESS AND SUSTAINABILITY
- INCREASE AIRLIFT CAPABILITY
- MODERNIZE TACTICAL FORCES
- INCREASE USE OF SPACE IN AIR FORCE OPERATIONS

**MAINTAIN A SMALLER, QUALITY FORCE STRUCTURE**

HASC7MAR

I think it is important to note on tab four that we have listed our priorities. There again they are by mission area. The first priority must be our people. They are the first asset that we must turn to for support and to develop our projects. I believe the Air Force leads all services in acquisition training, both our civilians and military. We have an acquisition career field for our military and our civilians. We are now certifying qualified individuals to get what we believe will be a pool of fine managers for the DOD process. This is a formal process and at some time we would be pleased to describe how people are screened to become program directors.

The priorities in our budget are shown as modernizing the strategic forces, that really should continue to be modernized. We must balance that with a high state of readiness and sustainability. We have got to increase our airlift capability. We must modernize our tactical forces to keep up with the threat and we have set out to increase space in Air Force operations.




Now let me talk about the research and development process. At tab five you have a chart which we have blown up so that more people may see. It shows the continuous relationship between our science and technology programs and the mainstream research, development, test and evaluation program effort of the Air Force and how these two relate to the threat and to technology opportunity.

On the left of the chart I will cover the science and technology process and then General Yates will follow to show how a major program gets to be a program and what happens as the program flows down the right hand side of the chart which is the acquisition portion of this process.

# AIR FORCE S&T PROGRAM

- PROVIDES TECHNOLOGY FOR FUTURE MILITARY CAPABILITIES
  - •• CAN BE 10-20 YEAR LEAD TIME FOR TRANSITION
  - •• INCLUDES USER AND THREAT DRIVEN TECHNOLOGIES
- REQUIRES A BROAD AND BALANCED SET OF TECHNOLOGIES
  - •• CORE PROGRAM TO SUPPORT ALL AF MISSION AREAS
  - •• EVOLUTIONARY AND REVOLUTIONARY TECHNOLOGIES
  - •• MAINTAIN TECHNOLOGICAL EDGE

If you start in the upper left of that chart, it is necessary to lead the production process by ten to 20 years. It starts off as just a bright idea in the pure research area, in the disciplines of math or physics or chemistry, but then these ideas get shaped by the threat. How can I get to the target without being shot down? The users' needs. "I need to see the target at night." Then system development affects it. How do I get all the necessary equipment into the small size of our aircraft and have them reliable and maintainable.

So we must have a broad set of technologies in our program because we are supporting a broad set of systems and sub-system to do our job. We must maintain the technology lead and that in this case is both quality and quantity. We find we compete with our international neighbors, some friendly and some who are adversaries, but that process of preserving a technological lead is ongoing all the time.

# AF SCIENCE AND TECHNOLOGY

**INCLUDES**

6.1 • RESEARCH
- •• BASIC RESEARCH IN UNIVERSITIES, INDUSTRY, IN-HOUSE

6.2 • EXPLORATORY DEVELOPMENT
- •• DEVELOP TECHNOLOGIES OF POTENTIAL MILITARY VALUE
- •• LABORATORY O&M

6.3 • ADVANCED TECHNOLOGY DEVELOPMENT
- •• EVALUATE TECHNOLOGY IN MILITARY ENVIRONMENT
- •• GENERIC APPLICATION
- •• TECHNOLOGY TRANSITION

We have broken our general structure down as we submit the budget to you, into 6.1, which is our basic research, the broadest area of the pyramid. Most of this work is done in universities. The 6.2, exploratory development area which is our technology base which is where we fund our laboratory O&M, our people and also lay the in house technology base for our future efforts. The 6.3 area which is advanced technology development is beginning to approach systems. We use that area for demonstration, military utility, and budget category for risk reduction. I think it is important to note that we also included in each of these categories, the necessary support for logistics efforts.

We do have a research and development effort to support logistics, maintainability, sustainability, battle damage repair, the so-called paper less flight line where we are trying to transfer data electronically.

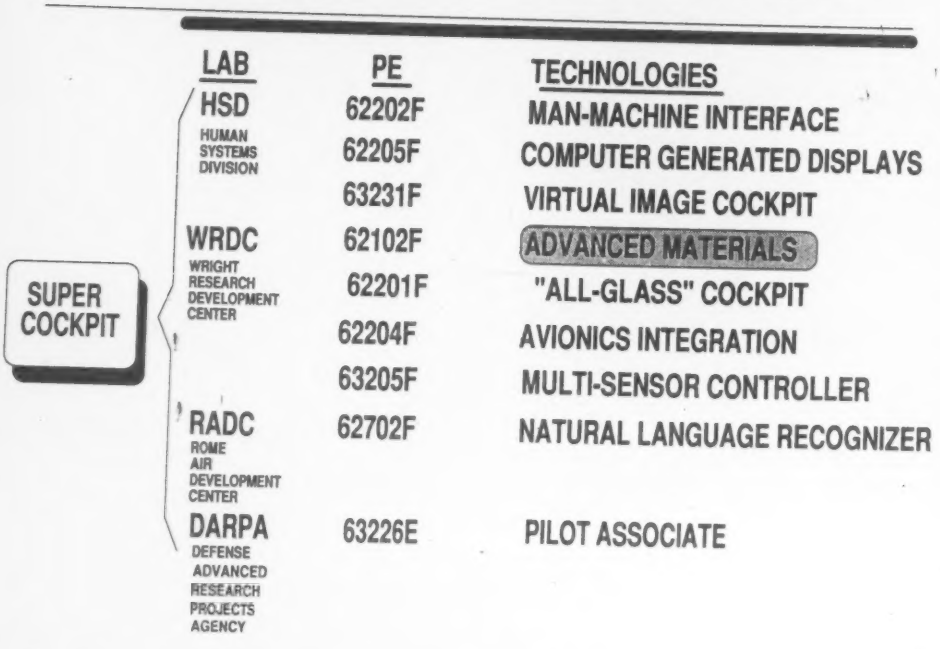
# BALANCED PROGRAM

- TECHNOLOGY AREA(S) MANAGED AS AN INTEGRATED INVESTMENT
  - 13 TECHNOLOGY AREAS/PLANS/ROADMAPS
  - ACROSS 6.1, 6.2 AND 6.3 PEs
  - INCLUDES "CROSS-LAB" ACTIVITIES
- HARMONIZED WITH OTHER SERVICE/AGENCY EFFORTS
  - OSD ISSUES POLICY
  - OSD CONDUCTS TOPICAL REVIEWS
  - JOINT DIRECTORS OF LABORATORIES
  - INTERNATIONAL EXCHANGE PROGRAM

These are all covered within these three categories of research and development. We manage these areas by creating 13 technological road maps. In the latter part of today we will walk through one specific road map so you can see how we cluster the various disciplines as well as the various needs so that we can follow along, much as we follow along with a road map for fighter modernization or strategic modernization.

The technological area roadmap plans encompass all the way from basic research to advanced development. In addition to broad technology areas, we also focus our research programs.

# TECHNOLOGY INTEGRATION




On tab nine it illustrates a number of the program elements in support of our basic research thrust of our program. We have tried to illustrate on the left that for a program like super cockpit, which has a single manager, the super cockpit program is really a vision of the future, the way we would like to see our cockpits for our aircraft.

# ENABLING TECHNOLOGIES

## TECHNOLOGY APPLICATIONS

ADVANCED MATERIALS
PE 62102F

- NASP
- HIGH PERFORMANCE TURBINE ENGINE
- HYPERSONIC PROPULSION
- SMARTSKINS
- STEALTH TECHNOLOGIES
- COOLING OF HOT STRUCTURES
- ADVANCED RADOMES
- AGILE LASER HARDENING
- SUPER COMPOSITES
- COMPOSITE MISSILE CASES
- METAL MATRIX SPACE STRUCTURE

It is a vision rather than a specific project, like I show on the chart, similar to the DARPA program and a pilot associate. It also shows that we combine a large number of program elements of our research and development, several of our laboratories, all in support of a single program. I have highlighted advance materials on this chart because if you look at the next chart you will see that our materials road map includes items that support the super cockpit. What is intended by these two charts is to show you that many of our research elements are inter-related and balanced, and that this balance must be considered in managing and budgeting for technology. So as you are reviewing each of the items in this budget, we would like to have a recognition of this inter-relationship. For example, if the super cockpit funding got hit that hit would ripple into our advanced materials program, it could have a straight forward impact on our technology base and our research effort that might be supporting other Stealth technologies or other missile programs.

UNCLASSIFIED

# SCIENCE AND TECHNOLOGY

FY90 RDT&E $1585 / FY91 RDT&E $1717

| | FY90/FY91 |
|---|---|
| NATIONAL AEROSPACE PLANE | 300/390 |

| $ in Millions | FY89 | FY90 | FY91 |
|---|---|---|---|
| RDT&E | 1539 | 1585 | 1717 |
| 6.1 BASIC RESEARCH | 196 | 220 | 224 |
| 6.2 EXPLORATORY DEV | 574 | 580 | 592 |
| 6.3 ADVANCED TECH DEV | 768 | 785 | 901 |
| NASP | (230) | (300) | (390) |

| | FY90/FY91 |
|---|---|
| RESEARCH SCIENCES | 220 /224 |
| AVIONICS | 185 /198 |
| AIR VEHICLES | 128/133 |
| HUMAN SYSTEMS | 119 /125 |
| AEROPROPULSION | 116 / 126 |
| COMMAND, CONTROL, COMMUNICATION, AND INTEL | 113/116 |
| ADVANCED WEAPONS | 103/ 93 |
| CONVENTIONAL ARMAMENTS | 79/ 81 |
| MATERIALS | 72 / 74 |
| SPACE AND MISSILES | 70/ 75 |
| GEOPHYSICS | 46/ 46 |
| COMPUTATIONAL SCIENCES | 19/ 20 |
| CIVIL AND ENVIRONMENTAL ENGINEERING | 15 / 16 |

MODS13

So there is a very tight inter-relationship in what we have submitted to you. Chart 11 is a budget summary. We accumulate our budget for talking purposes into 13 technical areas or road maps that I spoke about before. We try to manage this research and development program with executive direction over each year. As an example you will note that the 6.3 effort is about 50 percent. In the advanced development effort of 6.3 we have targeted for approximately 50 percent with the other 50 percent split between our exploratory development effort and our basic research effort.

We have protected our basic research effort to keep it in line with the growth of inflation so that we don't unbalance one in these particular times. We have one item outside of the technology base effort, the National AeroSpace Plane is the single largest element within the science and technology program. So to close this part of the discussion, we are really asking for support in keeping this budget submission of RDT&E in balance, I would like to assure you that we have coordinated each of these programs with our sister services and with the other agencies of the United States Government that are involved in the R&D area.

# S&T MESSAGE

- S&T PROGRAM CAREFULLY BALANCED
  - REFLECTS CURRENT PRIORITIES AND USER NEEDS
  - MISSION AND TECHNOLOGY AREAS HARMONIZED
- S&T PROGRAM IS WELL COORDINATED WITH OTHER SERVICES/DEFENSE AGENCIES
- SUPPORT THE AF S&T BUDGET

With this, General Yates will pick up and finish this part of the cycle on the R&D side, with how does a program get to be a program.

## Prepared Statement of John J. Welch

THE HONORABLE MR JOHN J. WELCH, JR.
ASSISTANT SECRETARY OF THE AIR FORCE FOR ACQUISITION
LT GEN (SEL) RONALD W. YATES
PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR ACQUISITION (NOMINEE)

INTRODUCTION

Mr. Chairman and Members of the Committee:

I am pleased to appear before you to review the Air Force's proposed acquisition activities for Fiscal Year 1990 and 1991.

In my testimony today I will focus on the progress and plans for Research and Development within the overall accquisition budget. Please note that the written statement I am providing today is based on the Reagan budget. Our formal Acquisition Statement will be provided to you when the amended budget is complete.

In rapidly changing times the best results often accrue from steadfast progress along a reasoned path, with a responsiveness to opportunity which is tempered by history's lessons and common sense. The United States Air Force Acquisition Program outlined in this report is designed to provide the systems and equipment needed by our Aerospace forces to implement our basic military strategy of deterrence in the most efficient manner possible. This program has been formulated against a background of political and technological change of unprecedented magnitude. While Soviet statements and proposals show remarkable reversals in world view and internal workings, those statements are most remarkable for their difference from past Soviet words and actions. They are not yet remotely similar to what we hear and see every day in modern democracies. In addition, General Secretary Gorbachev, though extraordinarily successful to date, is vulnerable in his own country to the consequences of failure. Therefore, we must base our military planning, and therefore our development and acquisition of new systems, on the current capabilities of the Soviets, not their early proposals or our own tendency toward optimistic evaluation of their intentions.

The Soviets do not represent our only concern in the world. Our close neighbors in Central America, our friends in the Middle and Far East, in Africa and South America face challenges to their security which could result in a call for our assistance. In addition, in some countries of the world there is bitter hostility toward the US, demonstrated by both words and action in the form of terrorism. We must therefore be prepared to support our friends, and protect our vital interests wherever they may be threatened. This demands the flexibility to participate throughout the spectrum of conflict, from low-intensity conflict to strategic nuclear war. That flexibility can not be created in one year or one budget. It requires a solid, continuing balance of readiness, sustainability, and modernization, all applied to a sound underlying force structure.

The Air Force budget which supports the Acquisition Program outlined in this report was painstakingly crafted to keep our

aerospace forces on a stable, prudent course for ensuring US security, balancing current readiness and sustainability with future investment. The programs in it were chosen carefully to continue the modernization of existing force structure while using economical production rates and multiyear contracting to replace older systems. The new systems proposed here take advantage of our newest sophisticated technology to incorporate higher reliability and better supportability at lower cost. In our deliberations we sought a balance among required military capability, program priorities, and budget realities.

The Air Force has kept steadiness and fiscal responsibility in mind as it prepared its budget request. Funding stability will allow us to realize the cost efficiencies and economies we have built into this budget. Given the funding, our success will depend on our ability to get the most from every dollar allocated to us.

We continue to emphasize people as the first asset to develop and support. The Air Force has traditionally led the services in acquisition training. We have long recognized that acquisition demands the dedication of highly talented and trained military members and civilians to a career in this specialized field. Certification of qualifying individuals, now underway, will provide us a pool of the finest acquisition managers in the Department of Defense.

Our remaining priorities for this budget are:

- Modernize strategic forces
- Maintain a high level of readiness and sustainability
- Increase airlift capability
- Modernize tactical forces
- Incorporate our improved ability to operate in space into every mission area

SCIENCE AND TECHNOLOGY

Strong support of our Science and Technology (S&T) program is vital to maintaining the technological edge of our military forces. We have long based our military strategy on the premise that the technological quality of our equipment will overcome the existing Soviet lead in quantity. However, there is an ongoing decided increase in quality of the Soviet inventory due to an increase in their S&T investment and to undesired technology transfer to the Soviets from the West.

The Air Force S&T effort is an Air Force Executive Program and is funded as a corporate investment. There are three basic categories: Basic research (6.1), exploratory development (6.2),

and advanced technology development (6.3 ATD). In the Air Force most of the 6.1 efforts are managed by the Air Force Office of Scientific Research and are conducted primarily at universities. The 6.2 efforts are managed by Air Force laboratories and develop technology to the point that feasibility for Air Force applications is demonstrated. The 6.3 ATD efforts further develop technology with more integrated component demonstrations of military utility. Assisting in these efforts are cooperative S&T agreements/joint programs with the Army, Navy, DARPA, and NASA which maximize our return on investment and prevent duplication of effort. After the ATD stage the technology has been matured and it transitions from the laboratories to application in system development.

S&T thus provides the technologies for our future military capabilities. While it often takes 10-20 years for an idea to transition to an operational capability, we are in a technologically superior position today because of the laboratory programs of the past. Our programs are based on both user requirements pull and technology push. We are in close touch with the user community not only to meet their near-term requirements but also to anticipate future operational needs. We capitalize on emerging technologies for new warfighting capabilities.

To do this effectively we must continually develop a broad and balanced set of technologies. There is a core program to support the entire Air Force mission area. To carry out this core program we have several laboratories and program elements. These laboratories meet this diverse challenge by developing both evolutionary and revolutionary technologies. Evolutionary efforts are undertaken to improve our current warfighting capabilities. They include technologies such as turbine engines, simulators, combat logistics and conventional armament. Revolutionary efforts look into the future using the latest in science to make quantum advances in weapon system performance. They include such technologies as those supporting the National Aero-Space Plane (NASP) technology program, high energy lasers, and high power microwaves.

STRATEGIC MODERNIZATION

The strategic modernization program, our number one priority, will ensure that our forces and associated command, control and communications are ready, sustainable, and survivable to meet their peacetime and wartime missions. The Air Force responsibilities in this program are:

- Improvement of capability including accuracy, and reduction of vulnerability of land-based missiles
- Modernization of the strategic bomber force and their weapons
- Improve our command, control, and communication system

To meet these responsibilities, the budget continues the procurement and deployment of the Peacekeeper missile and development of the Rail Garrison basing mode for Peacekeeper. Bomber modernization, through deployment of the B-1B, assures our most versatile leg of the strategic Triad retains credibility while the B-2 Advanced Technology Bomber development and production program prepares to fill the long-term requirement. Continued modernization of B-52s and their transition to a standoff cruise missile role coupled with the deployment of the B-1B and B-2 maximizes the capability of these systems in today's environment. To accompany our bombers, we continue to pursue updated weapons, including the Short Range Attack Missile II (SRAM II), the Advanced Cruise Missile, and the HAVE NAP medium range precision guided standoff conventional missile.

Strategic defensive forces enhance deterrence by providing integrated tactical warning and attack assessment capabilities to detect, identify, and characterize attacks against North America. We are continuing modernization of our ballistic missile and atmospheric warning systems.

The modernization of strategic command, control and communications will be pursued through programs such as the Milstar system, the Ground Wave Emergency Network, and the Defense Satellite Communications System, among others.

READINESS AND SUSTAINABILITY

Ensuring our weapon systems can fulfill their mission requires appropriate numbers of trained operations and support personnel; sufficient levels of training and war reserve munitions; and adequate stocks of peacetime and wartime spares, repair parts, and equipment. In the current constrained fiscal environment, our best efforts are directed at optimizing readiness through improved training and balanced logistics support. For training, our most significant initiative continues with the development of the dual track pilot training system. For spares and repair parts, we are starting to lose ground as reductions in the spares account begin to affect 1990 and 1991 readiness.

FORCE PROJECTION

The objective of force projection is to get a sufficient quantity of personnel and equipment to the right place at the right time. Resolution of our long-standing shortfall in airlift capability will be accomplished through the upgrade or modification of current systems and through the development and/or procurement of new systems. The KC-10 Extender program enhances strategic mobility cargo capability while improving our refueling support for Navy and NATO fighters. Acquisition of the C-27A will provide a small, rugged, short takeoff and landing aircraft for theater airlift. The C-17 will provide additional theater airlift capability plus allow us to approach the fiscally-constrained goal of 66 million ton miles per day.

TACTICAL AIR MODERNIZATION

We must remain capable of countering any conventional threat in a decisive, timely manner. Modernization of our tactical forces is being pursued through a number of programs. To protect our combat readiness and sustainability while modernizing the force, we will draw down to 35 Tactical Fighter Wing Equivalents from 37. For this force we will continue procuring the F-15E and F-16s, while developing the Advance Tactical Fighter and, with the Navy, the Advanced Tactical Aircraft. To maximize the capabilities of the force, the Low Altitude Navigation and Targeting Infared System for Night (LANTIRN) is being deployed, the improved performance fighter engines will be evaluated, and a variety of new munitions will be developed and procured. These new munitions will arm our forces with several new and improved capabilities in air-to-air and air-to-surface roles.

Modernization of our E-3 Airborne Warning and Control System will continue its support of our tactical forces. Equally important, though, will be maintaining the E-3 as a flag ship of the nation. We must ensure it is survivable, and capable of meeting the changing threat both as a strategic and a tactical resource.

SPACE OPERATIONS

US forces increasingly rely on space-based systems for performance of peacetime and contingency operations. Improvements in space operations, a goal for some time, are now showing some results. Continued emphasis on these improvements will allow us to fully integrate space-based capabilities into all elements of our forces.

Our launch recovery effort has produced results by returning the shuttle to space and successfully launching all types of our expendable launch vehicles. Continued refurbishment of Titan IIs, and development and procurement of the Titan IV, Atlas II, and Delta II will assure a robust launch capability to lift into orbit our high priority payloads. Space-based support to our forces will be enhanced through the acquisition and launch of our global Positioning System navigation satellites and the development and acquisition of the next block Defense Meteorological Satellites.

The activities I've presented here today represent a carefully balanced program. Our Research and Development activities are vital to the technological quality of our future weapon systems. We are committed to support these activities, and equally committed to constant improvement of our acquisition management process.

Thank you, Mr. Chairman, for the opportunity to make this statement. We will be happy to answer your questions.

Mr. DELLUMS. Mr. Secretary. General Yates.

**STATEMENT OF MAJ. GEN. RONALD W. YATES, PRINCIPAL DEPUTY FOR ACQUISITION, DEPARTMENT OF THE AIR FORCE**

General YATES. Mr. Chairman, I am going to discuss the far right side of the large chart that you see. I will explain in some detail the milestones, zero, one, two, three, if you look at tab 13, I will talk about those in detail.

In subsequent charts I will lead you through each portion but first there are some general things I would like to talk about right up front. The requirements definition and process starts with the statement of need.

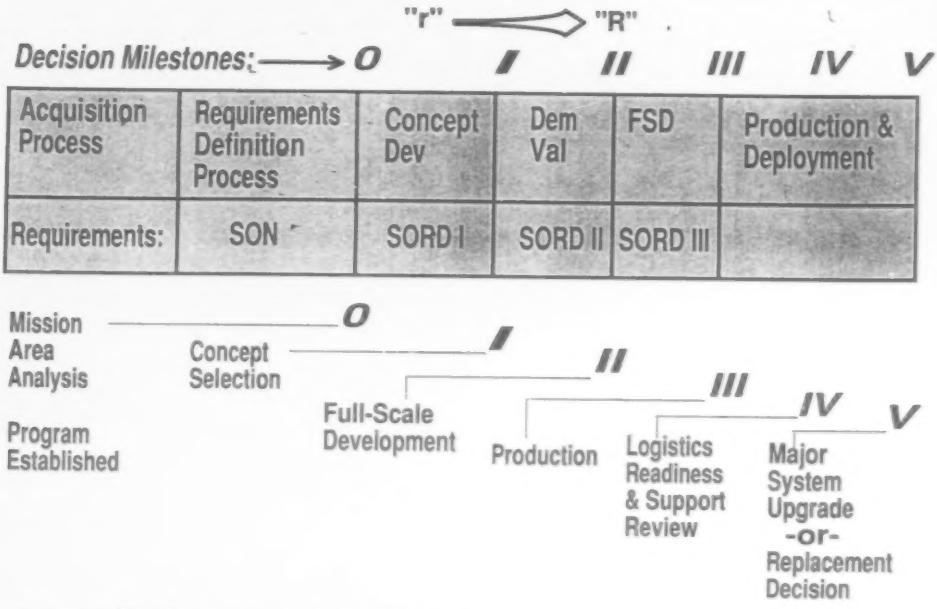
I will explain to you in just a chart or so, how that gets done by the using community. After the program is initiated, which starts at milestone zero, we go into a concept definition phase.

Now, that is a phase where we look at all the alternatives. For instance, if you are looking at space based wide area surveillance, it is during that period when you would look at options. Either doing that by radar or doing it by IR, and you would try to make a decision on that. At the end of milestone one, we would skinny down to one concept. By the way, if we have a program where several services are involved, it is at milestone one where we usually make a lead service determination.

Then we go into DEM/VAL, that is exactly where the ATF is now. We had a closed hearing yesterday and unfortunately the Chairman was ill. But we went through DEM/VAL in detail and I will talk about that later. That is where we do cost schedule "r" performance requirement trade-offs.

Then we get to milestone two which is where we enter full scale development. At milestone two is where the program is baselined to the service acquisition executive. For example, Mr. Welch. The reason we don't baseline the program prior to that is because we have to have the flexibility to make these requirements trade offs, as I was just describing. At the top of your chart at tab 13, you will see I have got a cartoon that shows a little "r" going to a big "R". It says, requirements with a little "r" grows to requirements with a big "R". They take on that cast at milestone two.

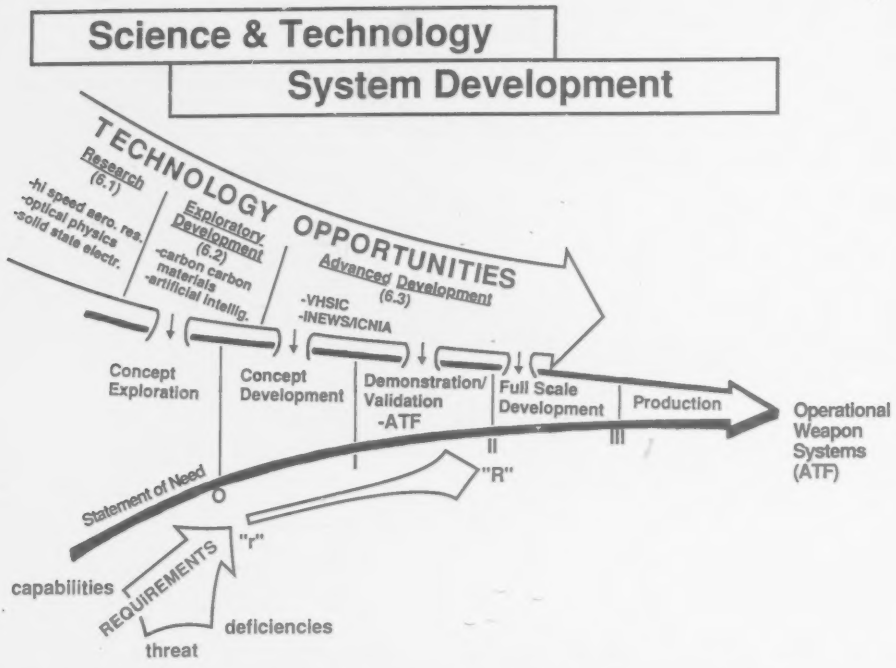
# PROGRAM MILESTONES




Across the bottom of the chart there at tab 13, you see the SON which I have talked about and then there is a SORD, a system operational requirements document. That is the growth of that requirement, from small "r" to big "R". The requirements the getting more specific, but there is one other really important thing that the SORD process does for us.

That is this: We have not done a good job either with ourselves or with you in the past explaining what we expect as a function of time from the systems. Just like all of us, these systems aren't born full grown, they are going to need to mature. So we need to describe to ourselves, to our independent testers and to the Congress what we expect as a function of time. By the way, that also characterizes how we view the risks as we go through the program.

So we need to be able to say what we are going to have on the first day and we need to say what we will have a year later. That is what the SORD process does for us. If I could ask you to flip to tab 14. This is the same information we have been talking about.




Mr. Welch has described the technological opportunities across the top. I have just described going through the milestones with you and I have looped those together. The ones I have listed in front of you are the ones that apply to ATF.

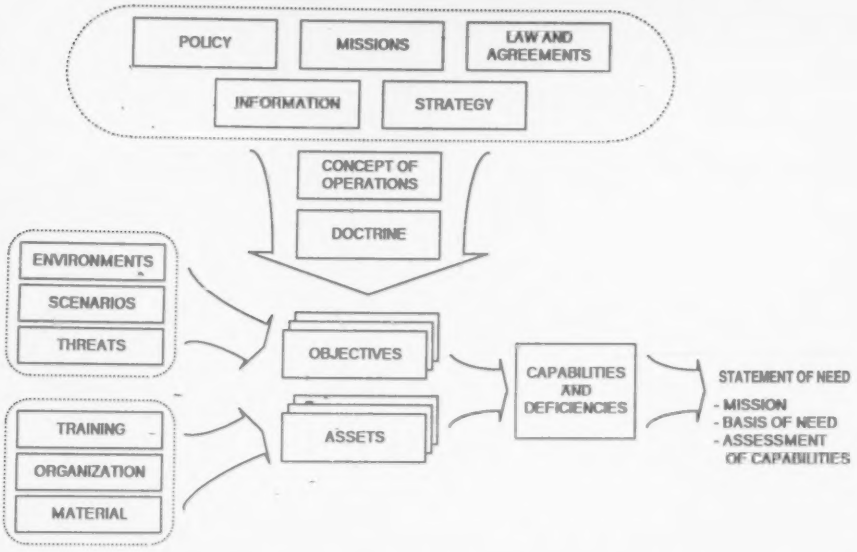
Since that has currently been on our minds, I keep playing off of that. You can see the specific technologies that came out of 6.1, 6.2, and 6.3 A and fed into the various phases that I was just alluding to.

You see the growth, across the bottom, from little "r" to big "R" and on the left hand corner of the chart is how we, in fact, generate the requirements—a statement of need. That is what I will get on to with the next tab.

This talks about what the user does. He starts with a set of, concept of operations and doctrine which come out of international and domestic laws, threats, treaties, current information, and his doctrine then plays into his objectives.

## MISSION AREA ANALYSIS

*(USER CONDUCTED)*

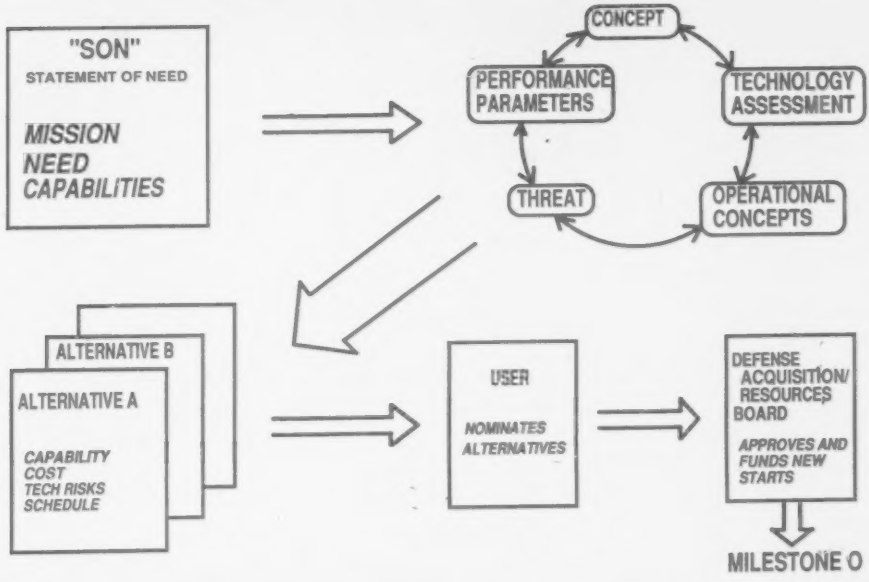



But the other thing that is playing into his objectives is what is going on in the present—that is how the threats are changing, how the environment is fluctuating. As his objectives are going to be modified by those influences.

Now he looks at the assets that he has to accomplish those objectives. Assets are his systems that the Nation has provided, the training and the people and the tactics that he can use. He matches the objectives against these assets and then he comes out with capabilities and deficiencies.

If he is deficient, he looks to change his tactics, modify the systems which he already has, and if it comes out the only way to satisfy the deficiency is with a new system, then he writes the statement of operational need. This kicks off this process that we have been talking about, sir, we now have a statement of operational need. Now we are trying to get through milestone zero. As I said, the first thing the user does is interface with the developing activity.

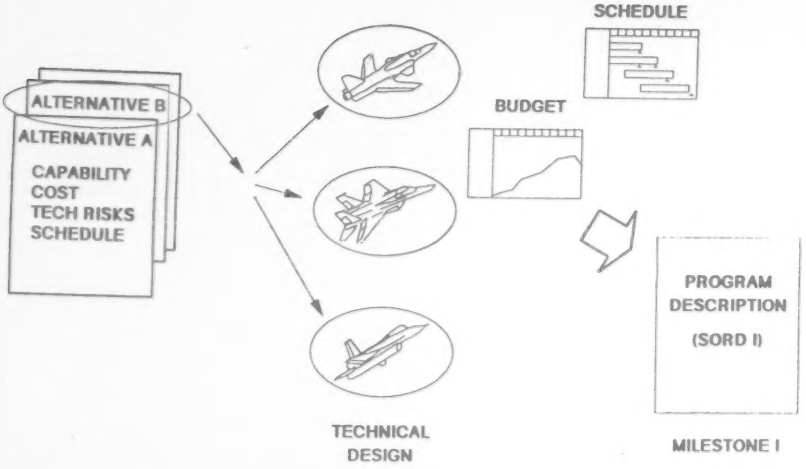
# REQUIREMENTS DEFINITION PROCESS




For instance, in the case of the Air Force, and if we are talking about ATF, Tactical Air Command and the Air Force Systems Command, and Systems Command makes known to him their assessment of technology, what technologies are available and that is the part that Mr. Welch was just been describing.

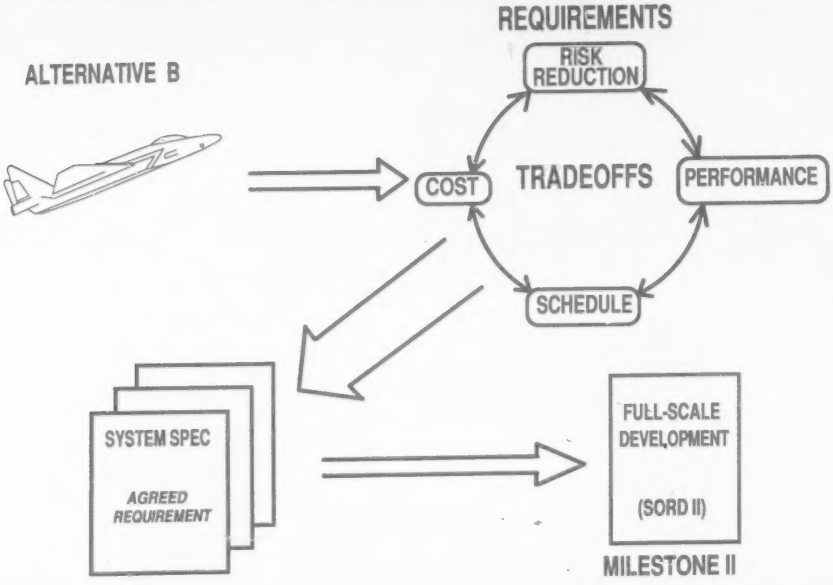
The user describes the threat, the operational concepts and performance parameters. Then that generates a set of alternatives. The user looks at those alternatives, nominates those most likely to satisfy his requirement, and then they come to the Pentagon. There is a defense acquisition board which basically approves the need. There is a defense resources board which basically approves the dollars.

# CONCEPT DEVELOPMENT




Given both of those, we are through milestone zero and that is the establishment of the program. Tab 17 shows how we enter concept development. Remember this is where I said you look at a lot of different concepts. On the slide that we have depicted, you can see that alternative B is looking at various types of airplanes. If you look at alternative A, it might be a missile. So we have not narrowed it down to where it is an airplane, a missile or a balloon that can do the job here. He is looking at the Air Force programs and budget and schedule information. When we are though this portion, we are now ready to go into milestone one.

## DEMONSTRATION/VALIDATION




This is the first time that we begin to update that statement of operational need, and then, we have the SORD I. If you would go to the next tab at tab 18. This is, as I described, where the ATF is now. There are a series of trade offs that go on between cost, schedule, performance, and the basic objective—risk reduction. I will be specific later on today about how we arrive at a system spec. At the end of this, he is ready to go into full scale development.

Here is where we have prototypes, for example. When we get to full scale development that little r has grown into a big R. If I could ask you to go to tab 19.

Mr. DELLUMS. Just 1 second to clarify for the chair's information and maybe for other members. You used the term risk reduction. Please give us an example of what you mean.

General YATES. All right. For instance, in the ATF, a key element of that is the avionics. We have been in the laboratory structure for some years working on programs which most of the committee members are familiar with. INEWS and ICNIA, which are COMMNAV, and identification and the integrated electronic warfares system. Those have been laboratory programs.

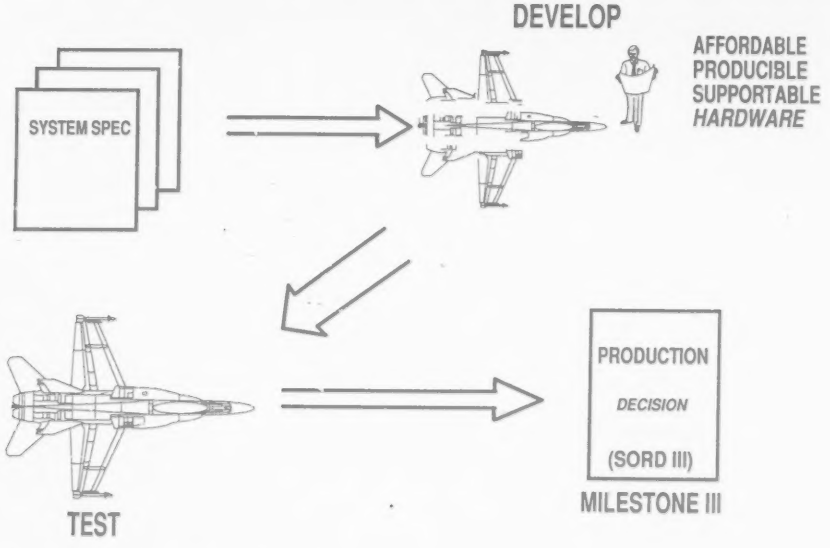
In the current phase of DEM/VAL, for the ATF, we will take those laboratory technologies, feed those to the competing contractors. They will come up with ground based simulators, air based simulators, and really hardware and fly that throughout the DEM/VAL phase. So that we are reducing the risk as we go through that whole process. When we get to the end of DEM/VAL we know more as to how to do Avionics and what to expect from the avionics than when we did to begin with.

It is at that point that we begin looking to write the specifications. If we had to write a spec today, we would probably do it wrong and that would be costly to us all, both in terms of dollars and time.

Mr. DELLUMS. So your risk is a risk of failure and vulnerability?

General YATES. Sir, I wouldn't confine it to just those two. I would say it certainly is those but also it is cost and schedule risks, too.

## FULL-SCALE DEVELOPMENT



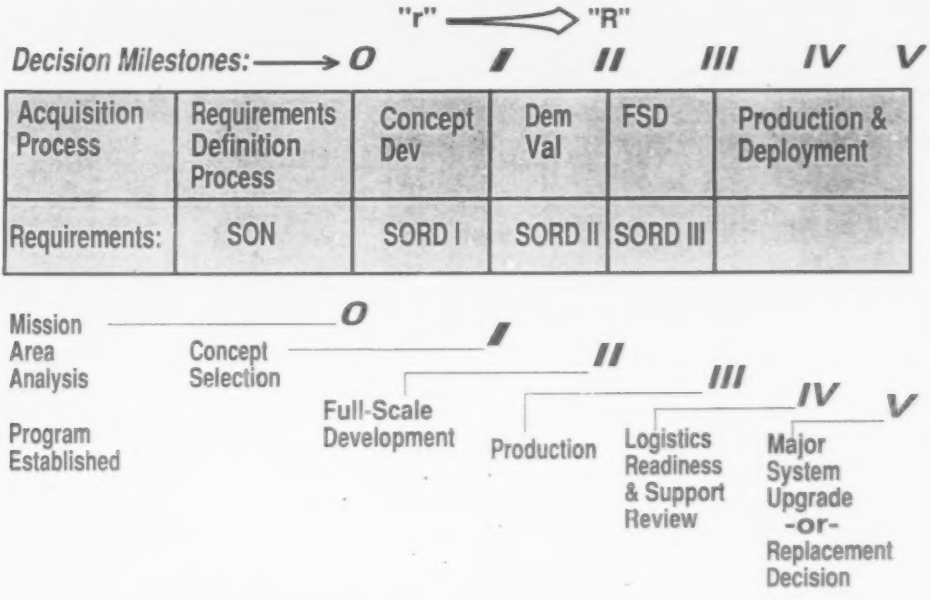

Mr. DELLUMS. Thank you.

General YATES. Tab 19, I am not going to spend much time on it. I think most of us are familiar with full scale development, but the system spec does then meet the requirement and the requirement is relatively firm. We go through the test process and come up to a milestone at which Mr. Aspin's committee is responsible for what happens.

I would like to make a point though as we go into full scale development, we are always authorized to get smarter as we go through this process. As we go into full scale development we are going to make changes to the requirements because we are going to learn things through the test process.

We do not want to be spending a lot of money on the last 2 or 3 percent. The threat is going to change, so there will be changes. But structurally, we don't build in the flexibility to change that requirement during full scale development as we have in the earlier phase because now we are really trying to build a specific item.

# PROGRAM MILESTONES




Sir, if I could ask you then to go to Tab 20, that is the same thing that you saw before. Hopefully, I have explained it to you. The points that I would like to mention in recapitulation are, one, threat and requirements are reevaluated frequently and they are compared with the system as it goes through development. Second, our scientific and technology community plays a prominent role throughout the whole development of the system.

Mr. Welch.

Mr. WELCH. Mr. Chairman, I think your question on risk is most appropriate. Sometimes we look at the acquisition business as risk management. A large number of the systems that are required for the defense of the country do, in fact, use advanced technologies and do, in fact, reach out with respect to capabilities. So we are certainly far from being in a risk free business, different from many in the commercial world who would develop on a risk free basis. So I think if you think of the job we have to do as risk management, it is easier to understand why we are always using the word risk in confidence as we build up our research and development programs to try to get to the place where we can confidently predict performance and a schedule and also the associated dollars.

## S&T ISSUES

- BALANCE BETWEEN R AND D
  - -- YES ... BUT
  - -- MANAGE AS A CORPORATE INVESTMENT
- A QUALITY WORKFORCE
  - -- EXTEND "CHINA LAKE" EXPERIMENT
  - -- USE EDUCATION AS INCENTIVE
- NEED TO MODERNIZE FACILITIES
  - -- LABORATORY
  - -- R & D
- MANAGEMENT
  - -- CONTRACT TYPE IN R&D
  - -- INDUSTRIAL BASE

To summarize from this segment, we have tried to show that we are driven by balance in our program. There are a lot more technologies and more research we would very much like to do. Some just don't make the cut in the available dollars. We have also looked at trying to manage our research and development as a corporate decision. In trying to overview it and test its reasonableness as a percentage of our total obligational authority, to make sure we are staying in some reasonable and reference base from our past experience.

In other words, the dollars invested for dollars returned that we have learned over a period of time. We also use these programs to communicate with our industrial people so that they can see where our interests are and so they can also invest with their own discretionary money. It is a balance of not only what we do in house and on contract, but also what the defense industrial base does with their discretionary expenditures.

The quality of our work force is also an issue that comes up all the time. I think many of you have talked about the China Lake experiment, an attempt to incentavize our people more, and to have a bit more freedom within the salary structure of the Government so that we can attract people into our laboratories and R&D structure and keep them over a period of time.

We have several experimental programs in the Air Force like Palace Compete and Palace Night, which feature not only the opportunity for compensation and experience in laboratory structures, but the opportunity for people to go on to higher graduate degrees in post doctoral work so we can keep a fresh work structure.

The need to modernize our facilities is always an issue. I think when our colleagues from the Navy were here the other day, they were talking about their facilities being replaceable over about a 250 year cycle. I think we are probably in exactly the same ball park.

I would comment that in most industrial areas when an analyst is looking at how healthy and how forward looking a corporation is, one of the things they look at, is to see if they are investing more capital than the depreciation of the facilities they have already have. We are far, far below in any of our programs here, being able to get on a replacement cycle that would match any depreciation cycle of the commercial area.

It is a very big challenge. It is also a very large investment. There is more than $1.5 billion worth of facilities in the RDT&E area on a replacement value just within the Air Force. The R&D not just the laboratory facilities, as we move more and more into an area where electronic combat becomes integral to all of our mission areas, having the ranges and the facilities to test our systems after we have developed them and get them into flight test.

It is challenging, and a challenging technical area to put those in. We have to build those up in the future.

Finally, in the management issue area, you might wish to discuss the contract type in R&D. I believe the Air Force has always maintained a posture of trying to match the appropriate contract type with the work to be done without a fixation of contract as perhaps some have been accused in the firm fixed price arena.

I believe we do have good acquisition strategy panels. We have a good program that matches type of contract with the type of risk that the contractor will assume and the type of compensation that can come for assuming that risk.

But we should not impose a contract type that asks the contractor to assume more risk than he can bear, whether in the performance segment or the financial segment of business. I believe that it is well in line today and we continue to look at each firm fixed price contract not only in line with the legislation that has been passed, but also in line with good business.

Finally, in the industrial base, we are encouraging people to participate and with discretionary expenditures by virtue of encouraging independent research and development and bid and proposal programs. We will continue to communicate closely with them on that because that is a very large leverage for us in the Government in terms of learning what can go on out there for that base.

We will stop here and see if we have identified the issues well for you on just the S&T. We will talk about the research and development in another segment and the specific road maps and the specific projects.

Mr. DELLUMS. Are there any Members who wish to ask any questions at this point in the process. Mr. Dickinson is recognized for such time as he may consume.

Mr. DICKINSON. I don't think that you identified or introduced your staff sitting behind you. The gentleman impersonating a one-star general back there, who is he?

General YATES. Without looking, it must be General Douglas.

Mr. DICKINSON. The last time I saw him he wasn't a general, I will tell you that. You didn't have but two buttons when I saw you, too.

General YATES. It is an indication of gross inflation.

Mr. WELCH. Of course, only the military gets promoted.

Mr. DICKINSON. We just want to welcome you all here and I like your passing remarks about the salary schedule, Mr. Welch. I don't think you bore in heavily enough on it. As as I understood your remarks, it dealt only with your technical people, but there are others interested in the broader spectrum of pay adjustments here.

I am particularly interested in the modernization of the ICBM program and some other things. Have you finished your general presentation now or will you get into that later?

Mr. WELCH. We had set this up, to be a two-part hearing and we had a break here. We can move right on.

Mr. DICKINSON. No, the Chairman just advised me that that is to be next. I will be glad to wait.

Thank you, Mr. Chairman.

Mr. DELLUMS. Mr. Darden is recognized for such time as he may consume.

Mr. DARDEN. Thank you. I will be brief. I welcome the witnesses here and thank them for their participation here today.

Gentlemen, we have been holding hearings on the issue of the 6.1, the 6.2, and the 6.3 A functions. We have had experts from the Kennedy School, Stanford, and everywhere else, keep on emphasizing the importance of basic research, the 6.1 function, the 6.2 function and whatever. If it is so important to you why is it such a small percentage of the overall total of our DOD, R&D budget? It seems to me that if it is that important, and everyone has such great belief in its future that it would have more robust funding support and perhaps we should cut back on some of the other parts of the pie which seem to be inordinately expensive.

Could you comment on the balance and the mission here?

Mr. WELCH. Without being facetious, Mr. Darden, I had hoped I commented on the balance all through my briefing. It is difficult, 6.1, is research and the smallest number. We worked very hard on a policy basis to protect it, to include inflation. That is the thing that supports our university research program, the Air Force has 80 percent of that money goes outside of the Air Force.

So we use it for those people in industrial sectors doing some basic research but fundamentally for the university. So I think we have done exactly what you suggest. We believe that is a good balance number and that percentage in 6.1 has stood up over the years.

The 6.2 area is divided into two parts, but 40 percent of that is required for the people in the operation and maintenance of the 14 laboratories that the Air Force has. We are working with 60 percent of that in terms of what we are able to contract with and go outside.

So if you look at that as the basic technology and the research, we have taken 50 percent of our money and put it in there. When you go into 6.3A, which are those things which will compete to become systems, the list is much, much longer. It is truly a judg-

ment call. If we build those up, we would come up with a much larger number.

That is when we overlay. As a policy statement, we would like to see the science and technology program of the Air Force up in the 2 percent arena rather than down in the 1.5. But you have to look at both the short term and the long term as we look to meeting our mission needs.

Mr. DARDEN. We are talking about policy today, essentially?

Mr. WELCH. We have come from a policy down standpoint. If we had our desires, we would like to get in the 1.7 to 2 percent of the total obligational authority of the Air Force into the S and T kind of base. That is where we challenge ourselves each year.

On the other hand, we build our budget process on a line item by line item basis. We just try to balance the two against each other.

Mr. DARDEN. I don't mean to be argumentative here, but everyone comes in here from the think tanks, from the universities and private sector and they bemoan the fact that our industrial base is eroding. We need to put more money into basic research, whatever, and it just appears that this is a very small amount and that we aren't doing very much to address a problem.

I have only been here since 1983, Mr. Chairman, but every year we hear the same problem stated each and every year and we don't seem to do anything about it except to protect the most basic research. It just seems like every year everyone comes together and says it is a bad situation. Then as a response, we kind of leave things as they are, walk off and come back again next year.

Mr. WELCH. This year we have to go by history in terms of percentage and total obligation authority. The Air Force being the youngest of the services has probably felt and ground on technology and the tech base more so than others. But we believe we are matching history to that basis. Also, the people who come to suggest that more investment be made in this area are people who have very good ideas, ideas which, in many cases for us, do not have a specific military application.

I think we have been very careful to make sure we are focused in. You will notice in several of our programs there is super conductivity, it is a broad based research program in the United States now. There are only very specific applications to the military. So we do not have a broad based super conductivity program.

The commercial world of computers is such that they can do much more in the R&D area that we can. So we look at specific applications like hardened computers, ruggedized computers.

General YATES. I might add one thing, Mr. Darden, and that is, while we have already said that we would like to see more in this area as you have, I think we do need to keep what we are doing in perspective because what we are asking for in fiscal year 1990 is $1.6 billion. That is a lot of money and in fiscal year 1991, $1.7 billion for this area. So by any standard, if you judge this on that basis, if it were a program and you were looking at our other major programs, there are very few programs we spend that amount of research and development every year ad infinitum.

Mr. DARDEN. What is the SDI request, for example, this year?

General YATES. I think it is large.

Mr. WELCH. It will be over $3.7 billion which it was last year, but keep in mind that includes their programs and all. You make a very good point here. If you were to take laboratory structure and see the way that we leverage this research, we spend in our laboratories probably twice as much money as is appropriated to the Air Force for the purposes of their science and technology base.

If you add the money that the DARPA budget, the SDI budget other program activities feed into the laboratories, the number which you saw on the chart today is only 50 percent of the S&T that we do in our laboratories.

Mr. DARDEN. OK.

Mr. DELLUMS. Would the gentleman yield? I would like to pursue my colleague's line of questioning and maybe come at it a little differently. But with respect to your science and technology budget, that is approximately $1.6 billion. However, it is interesting, that includes the 6.1 basic research, 6.2 and 6.3 which is advanced development.

If you take out 6.3 from that $1.6 billion, you really are talking about approximately $800 million for basic research out of a total budget of $14.8 billion.

So if you take your $1.6 billion beyond, a little over 10 percent of your request. However, if you take out the category 6.3 which is advanced development, and the B part of it leads you to potential prototypes. When you come to $800 million, you are now down to approximately 5 percent of the total budget really being basic research. An interesting comparison—the Army's budget, approximately $5.6 billion, has almost identically the same amount of money, $800 million for 6.1 and 2, although your budget is almost three times that budget.

The Navy's budget, as I recall is approximately $10.4 billion and their figure is also $800 million in basic research for category 6.1 and 6.2. If you look at the DARPA request, their budget is not nearly as large as your budget, they have approximately $900 million in basic research. So roughly all of DARPA and the other defense agencies have about the same.

The Army has roughly the same. The Navy has roughly the same. Now, although your budget is extraordinarily larger than all of those, your basic research dollar figure is virtually the same. So my question is why is that the case and why would your budget not reflect, on a proportional basis, a greater commitment to basic research and less commitment to advance development and full scale development?

Mr. WELCH. I can't comment. I am not sure of the direct correlation between those three budget numbers and the outcome. The dollar factor may be right, but each of the three services has a different mission. They break their missions down, the technology to support those is somewhat different. Certainly in some elements, as I pointed out within the Air Force, the application of computer science and other things, much of that research is being done outside of our budget.

So, I don't know that one can come to a conclusion with the diversity of the missions of the three services. The fact that the dollar number came out correctly, I think——

Mr. DELLUMS. I guess I am raising it in a very simple fashion. It could—at a very simple, non-complex level—make a statement with reference to the commitment to basic research.

Mr. WELCH. We have had a retrograde the last 3 years as far as real spending is concerned concerning the Air Force's commitment to basic research. In each of those times we have tried to maintain our basic research budget so that it equaled the inflation factor from year to year. We will not permit a retrograde on our basic research budget. It is a commitment. It has been shielded from many retrogrades.

General YATES. Mr. Chairman, if I might comment, sir. While clearly you can slice the pie the way you have with 6.1 and 6.2, I would make a plea for us not to do that because the dollars that Mr. Welch showed you earlier that are in our budget, the $1.6 billion that we have been talking about, that includes 6.3 A, and the 6.3A this work is not systems specific.

That is not where we are building prototypes, that comes out of program dollars. So it is still very generic in application and has some degree of realism. But those dollars we gave you still reflect on the research nature of the business.

Mr. DELLUMS. I appreciate your response. I made a brief note and would like to ask this one last question and then we can proceed to the second part of the hearing.

UNCLASSIFIED

# SCIENCE AND TECHNOLOGY

FY90 RDT&E $1585 / FY91 RDT&E $1717 FY90/FY91

NATIONAL AEROSPACE PLANE 300/390

| $ in Millions | FY89 | FY90 | FY91 |
|---|---|---|---|
| RDT&E | 1539 | 1585 | 1717 |
| 6.1 BASIC RESEARCH | 196 | 220 | 224 |
| 6.2 EXPLORATORY DEV | 574 | 580 | 592 |
| 6.3 ADVANCED TECH DEV | 768 | 785 | 901 |
| NASP | (230) | (300) | (390) |

| | FY90/FY91 |
|---|---|
| RESEARCH SCIENCES | 220 /224 |
| AVIONICS | 185 /198 |
| AIR VEHICLES | 128/133 |
| HUMAN SYSTEMS | 119/125 |
| AEROPROPULSION | 116/126 |
| COMMAND, CONTROL, COMMUNICATION, AND INTEL | 113/116 |
| ADVANCED WEAPONS | 103/ 93 |
| CONVENTIONAL ARMAMENTS | 79/ 81 |
| MATERIALS | 72/ 74 |
| SPACE AND MISSILES | 70/ 75 |
| GEOPHYSICS | 46/ 46 |
| COMPUTATIONAL SCIENCES | 19/ 20 |
| CIVIL AND ENVIRONMENTAL ENGINEERING | 15/ 16 |

MDDS13

In listening to the secretary with respect to Tab 11, the secretary spoke about not wanting "an unbalance". Even yourself, Mr. Secretary, pointed out that when you add up 6.1 and 6.2, that is approximately $800 million. When you take 6.3 that it was roughly the same and you did not want to incur any imbalances. So I am

saying even the Secretary makes a distinction with respect to category 6.1 and 6.2 and saying an imbalance in those two as against 6.3 is unwanted.

So I appreciate the comment you make, but the Secretary made a very different comment and I made a note of it when you said we want to make sure that there is rough equivalence between 6.3 and advanced development and 6.1 and 2.

So I am getting two apparently contradictory comments in that regard.

Mr. WELCH. I think we have a tendency to break the budgets down to the point of creating confusion. 6.3 has two elements to it, A and B. You do your DEM/VAl and specific risk reduction on programs. It would be very difficult to plot an absolute flat or growth budget curve on 6.3 from year to year because we are putting programs in and taking them out. ATF is a good example. When it comes out, it causes a down grade. But if you put that over a period of time, the 6.3 A, I believe that what General Yates was talking about is the part that is the generic.

I would further comment that again to illustrate the comparison of these budgets or not wanting to, DARPA was created to look at advanced research and the higher risk programs and, higher pay off type of research where they can make and should make a decision in terms of an investment that may have a very, very high pay off.

We work with them on those programs through our Memorandums of Understanding. But that would not fit our structure with respect to the way we would invest our early money and therefore we don't have a duplication. But the Pilot Associate program is a good example. They are proceeding on it in their minds on the basis that we can put that directly into the ATF. As we look at it, they really need a revolutionary break through on Pilot Associate or it would never make the risk cut off for the ATF.

So the comparison of these programs are difficult. We, like you, wish we could have some simple comparisons.

Mr. DELLUMS. I appreciate that, Mr. Secretary. I would yield back to the gentleman if he had final comments.

Mr. DARDEN. No, thank you, Mr. Chairman.

Mr. DELLUMS. General and Mr. Secretary, I think that the questions that are raised by Mr. Darden and myself simply go to the issue of the fact that there are a number of people in the scientific community who are saying that we are not making the necessary kinds of investment in basic research, taking needed risks, and that a larger and larger portion of our funds is going to development. Over the long haul, that will not be to our benefit because in many instances even our basic research is directly focused on a particular weapons system.

So in the scientific community there is the lack of flexibility and ability to explore with an ultimate potential of some of this basic research flowing back to the non military community as happened in earlier years in our history.

In fact, a conference a month or two ago concluded that we are not getting those benefits back to the general society and that because of a lack of commitment to basic research and a great commitment to development, that we are ending up as a Nation not

being able to, while we may have smart bombs and smart missiles, we are rendering ourselves impotent in our capacity to compete in the larger economic world.

Mr. WELCH. I think if more funds could be found to be put into the defense budget, we could find an exciting list of things that could be encouraged.

Mr. DELLUMS. I appreciate that. In the universe of limited resources, Mr. Secretary, that is a pie in the sky. Please proceed to the second phase of our hearing.

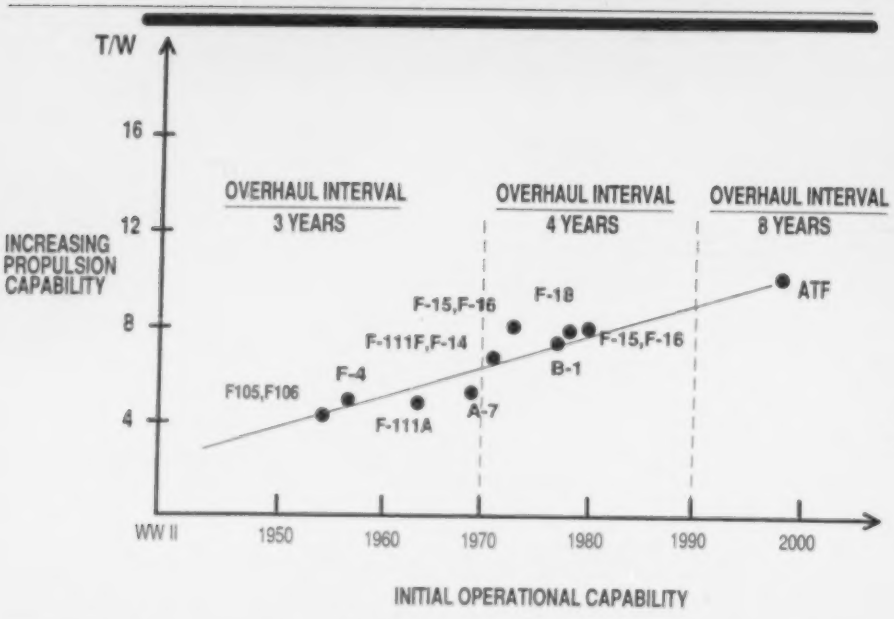
## S&T TECHNICAL AREAS

- AIR VEHICLES
- $C^3I$
- SPACE AND MISSILES
- MATERIALS
- COMPUTATIONAL SCIENCE
- GEOPHYSICS
- AVIONICS
- HUMAN SYSTEMS TECHNOLOGY
- ADVANCED WEAPONS
- AEROPROPULSION
  - TURBINE ENGINES
  - FUELS AND LUBRICANTS
  - RAMJET/SCRAMJETS
- CIVIL AND ENVIRONMENT ENGINEERING
- RESEARCH SCIENCES
- CONVENTIONAL ARMAMENT

Mr. WELCH. If I could ask you to turn to Tab 24, please. In the previous part of the briefing, we had accumulated, for purposes of management, all of our science and technology into 13 technical areas. Those are demonstrated here on the chart. If you would turn then to the next chart. Let me talk about just one of these road maps to show how it happens.

We will talk within the aero-propulsion area, about fuels, lubricants, ram jets, and scram jets because that is the way we gather things together.

# ENGINE PROPULSION CAPABILITY



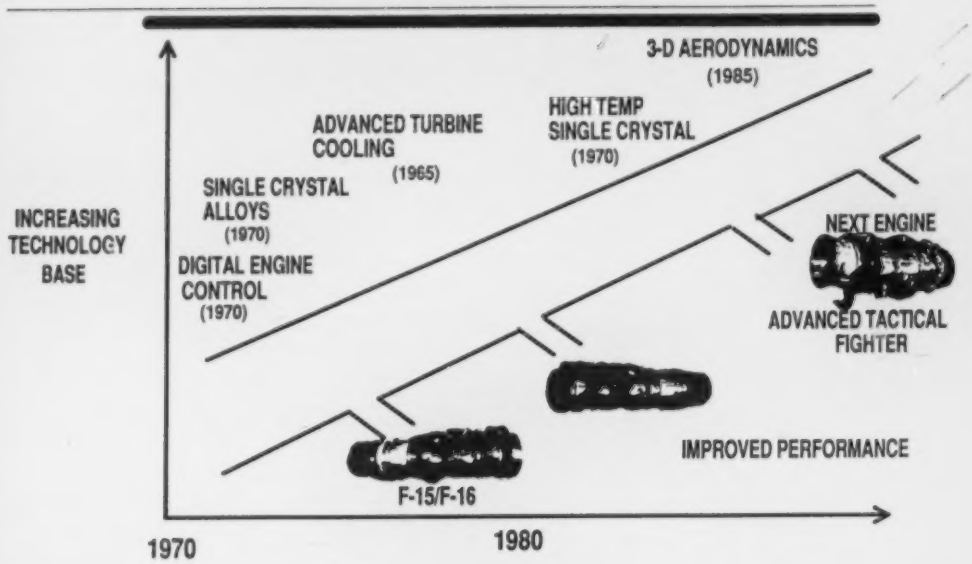

Simply shown on this chart is our engine propulsion capability. The key is in the high performance aircraft, not only to get the maximum thrust for our aircraft, but more particularly, to match specific fuel consumption, the type of engine cycle that matches with the way aircraft will fly their mission.

We can see the progress of thrust to weight ratio on this curve as increasing propulsion capability. It has gone from two at the end of World War II to today moving out to in excess of eight. We are looking forward to thrust weights of ten.

At the same time, I point out that we have particularly improved durability of these engines. Getting an engine with high thrust that cannot stay in the machine for a long period of time without taking all the maintenance support is only half doing the job.

The kinds of fuels that go into these engines, the lubricants for their parts, the programs to support building cores, the core of these engines and testing them and reducing this risk are all covered within the areas of the propulsion road map.

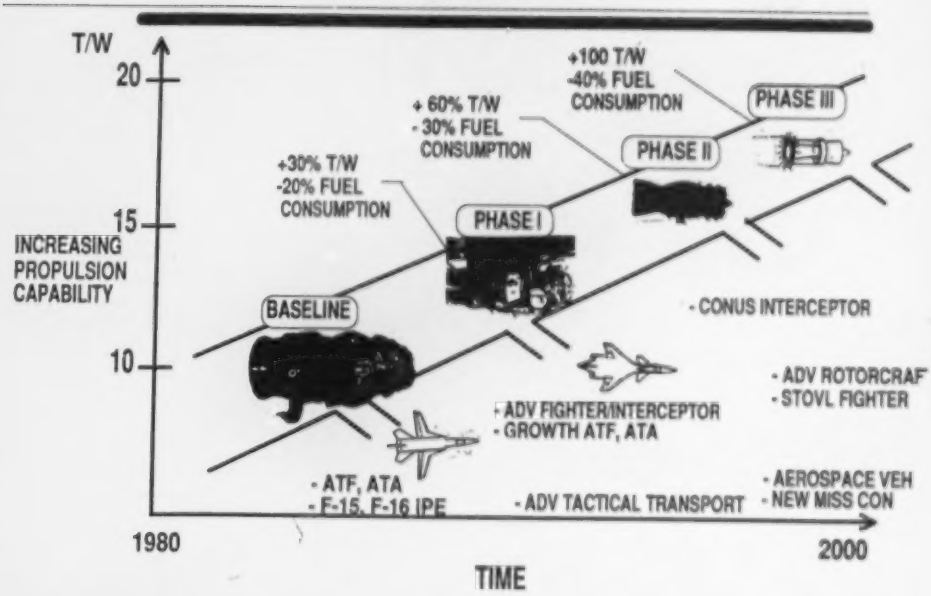
# TECHNOLOGY READINESS




Again, what we are trying to do is move from today's improvements in the F–100 series of engines to be able to constantly improve the basic materials technologies and the manufacturing technologies, the internal aerodynamics within the propulsion machinery.

You can see over a period of time that we have increased our technological base going to a fully digital engine control. It not only helps us with reliability but improves the performance of the engine. We have moved on to cooling systems, internal cooling systems within blades to give us the ability to run our turbines higher and to get closer to being able to use the total engineering content at the higher energies of the fuels that we use. We expect in our next engine cycle series to be able to make an air frame coupling and to begin to look at what is called super cruise, or effectively the ability to fly super sonic while using military thrust within an engine.

## ENGINE DEVELOPMENT PROGRAM




So all of those flow through one area and they are captured together. That is what we deliver to this committee in the way of descriptive elements of each of the efforts that make up the total propulsion road map. Another way of looking over the time period we have tried to gather on one chart between Tab 27, that our engines, I believe, are the envy of the free world. Every time we look to sell aircraft products, military or commercial, people are looking to install the engines.

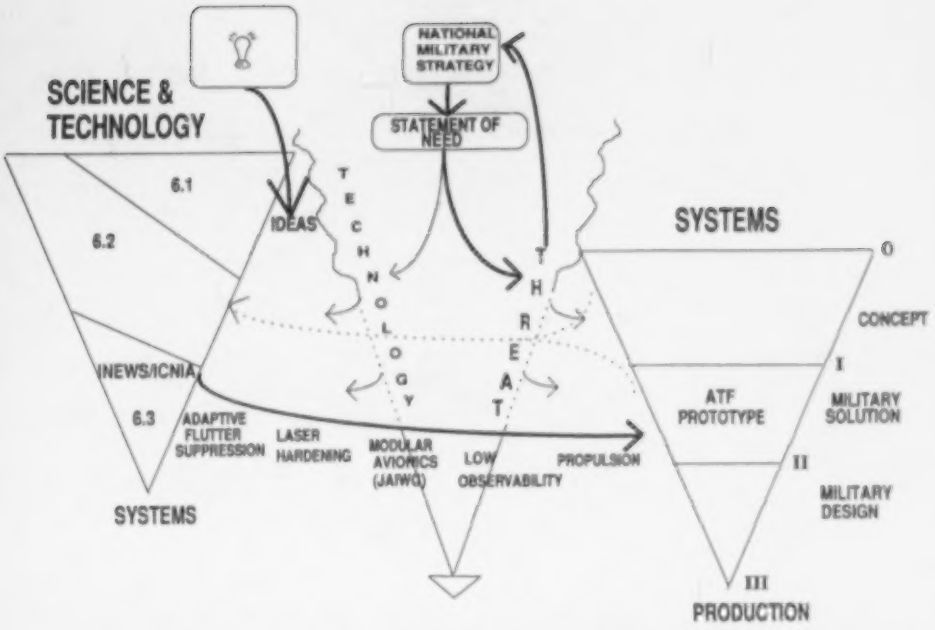
Again, not just from the standpoint of thrust or weight but from the specific fuel consumption in the energy market today. We continue to work on both evolutionary and revolutionary type technologies. This is a real base line program, metallurgical efforts and others that support the commercial American market place.

If I could return now to the large chart up here. The ATF is right in the middle of this chart. It is in the demonstration and validation phase. The first thing I would say is that we would not be able to accomplish this phase if it were not for the technologies that you see listed here that are flowing from the left side of that chart to the right side.

I would like to turn it over to General Yates and if we can walk through and down the right hand side of that chart with a specific example. Then we will turn to specific programs that the committee is interested in discussing.

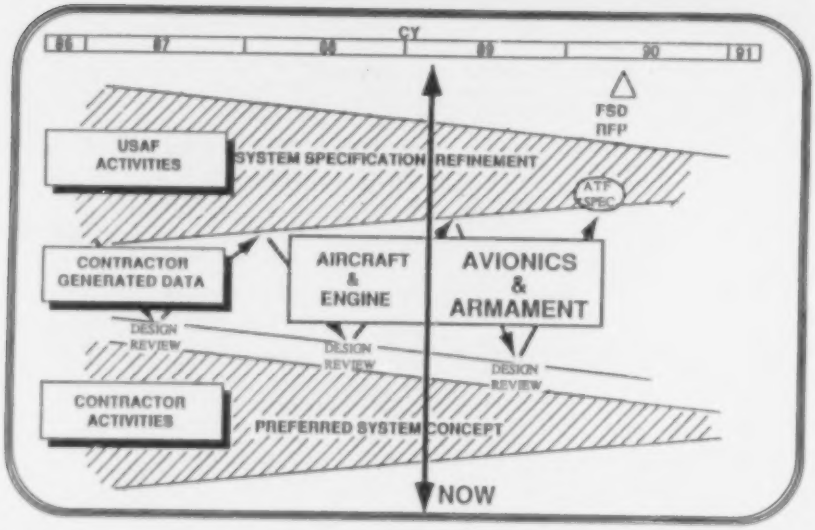
General YATES. Mr. Chairman, as Mr. Welch said, you see the ATF——

Mr. DELLUMS. This is the right side of Tab 28?




General YATES. Yes, sir, that is correct. The same as on this large chart here. Right where it says Military Solution and DEM/VAL, you see on Chart 28, right in the middle there is a ATF prototype. Then on Chart 28, you notice we have identified those technologies which found their way over from this S&T base over to ATF, and many of those we have discussed with Members of the committee before, in particular, Mr. Welch just highlighted propulsion. He said we would not have AFT engines today if we had not started 10 to 15 years ago.

# ATF DEM/VAL PROCESS



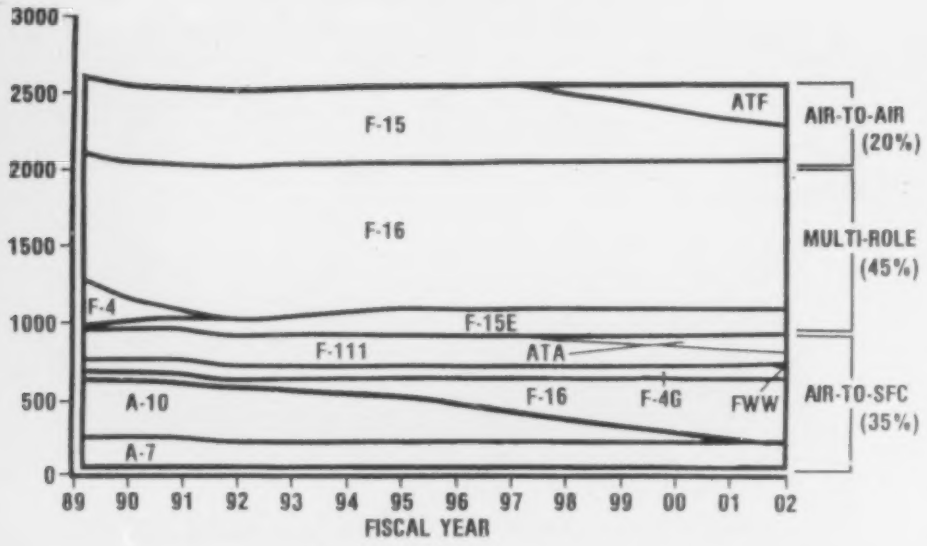

The next chart is Tab 29. Again, we looked at this the other day, it is an unclassified chart. We did look at it in a classified hearing and it is very important to understanding not only what is going on in the ATF, but the way we intend to do business.

The center portion of the chart represents contractor generated data but it really represents knowledge. You see on the left hand side we have not much and it expands with time as we go to the right.

That is the knowledge which is enabling the Air Force to tighten up its systems specifications. We have to do that as we go through the various milestones and furthermore at the bottom even with the contractor defining what his airplane will look like, that gets tighter. We go through various design reviews. So to put meat on these bones that we have been describing throughout this presentation, we really will not have an ATF spec until we deliver or release the RFP out in calendar year 1990.

That is when we get the big "R" again. We have just completed design review which basically sizes the airplane and the engine. You see we have in front of us the Avionics and armament. That is where we are and how the process works.

# TACTICAL FIGHTER FORCE




Sir, if you would go to Tab 30, I am going to start with——

Mr. DELLUMS. One question. When you get to this "R" phase you are now at, for the knowledge of the committee, you are now at 6.3 A or B?

General YATES. This is 6.3 B effort.

Mr. DELLUMS. OK. Let me ask you one question because I am curious. I meant to ask this earlier——

General YATES. Let me just finish that thought, sir, if I may. It is 6.3B going into 6.4.

Mr. DELLUMS. I am trying to learn this. You and I are both new in our respective jobs. Can you tell me whether or not, when the system gets to 6.3 B, has any system ever been stopped at that point?

This is not a tricky question, but I wondered if someone said the risks are too high. The decision is too risky. So, once it gets to 6.3(B), has any system been stopped, that you know of, in the Air Force?

General YATES. First, I accept your point, but I think I would put the YC–14 and YC–15 in that category. We did not go ahead with those airplanes as we had envisioned. Some of the technologies found their ways into the C–17, but we did not press on with those programs as we had originally envisioned them.

Mr. DELLUMS. For the most part, would it be a fair conclusion to draw?

General YATES. We had a lot of help from Congress, but I would say that ASAT goes into that category, too.

Mr. DELLUMS. I appreciate that. I tried to have a hand in that one.

So is it a fair statement to make—and if it is not fair, please respond—that once a program gets to the advanced development phase, certainly at least to 6.3(B), that there is an overwhelming lack of good that that project goes forward to procure?

Mr. WELCH. I think I really see the point you are headed for. I think it is 6.4 that is the more appropriate one. When you get to the milestone 2 part, where you have decided to go into full-scale development, you would be on the risk reduction phase. I think at that point the process has gone to the "R" and the dollars are in place. The teams are in place to do it. I would put that as the more appropriate kind of point.

But 6.3(B) in risk reduction, I think there are good examples and we could give you more. I think today, particularly with decreasing dollars, we will see more things fall out of 6.3(B) and not break over to full-scale development.

General YATES. If I could add to that, sir.

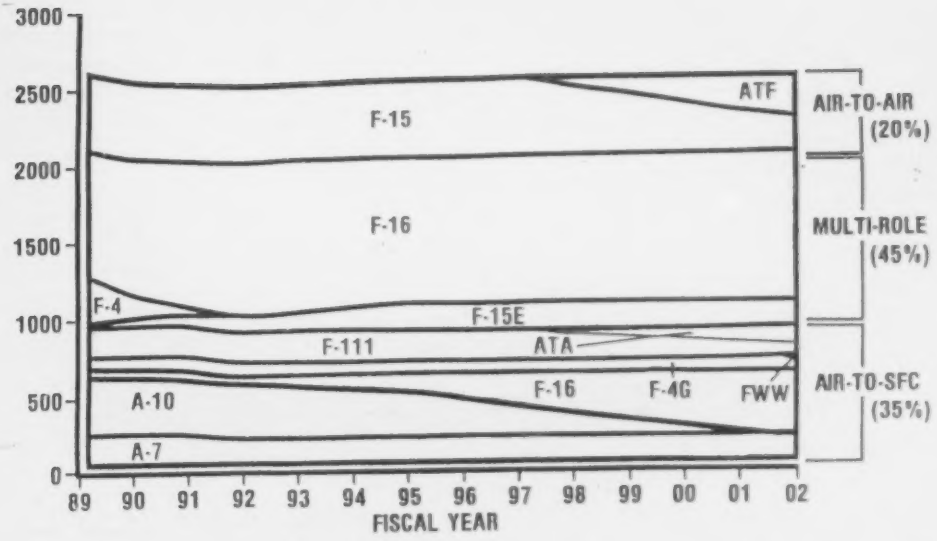
Away from major systems, I am familiar with a 6.3(B) project called AFTI-16. There have been a number of interesting technologies which have been demonstrated on the AFTI-16 that we have not incorporated into the F-16 fleet, not because they were not good or because they didn't necessarily prove out technically; they just were not affordable in terms of their military worth.

Mr. DELLUMS. Thank you, gentlemen. Please proceed.

General YATES. Sir, at tab 30 is the first of a series of road maps. I was asked by the staff now—and this whole presentation kind of comes to this point, but as we built up you asked us to start at a high level and explain this process, and hopefully we have been able to do that with you—and then the staff asked how does all of this lead to the Air Force determining what it will look like in the year 2000.

So through the process we have determined, and looking at the technologies, we laid out a series of road maps. I will walk very briefly through some of those which will contain the systems that we are all familiar with. There are other road maps but, because of the nature of this hearing today, the ones I have here are unclassified. There are others in the area of stand-off missiles and air-to-air missiles which have previously been submitted to Congress, which are of a classified nature.

# TACTICAL FIGHTER FORCE



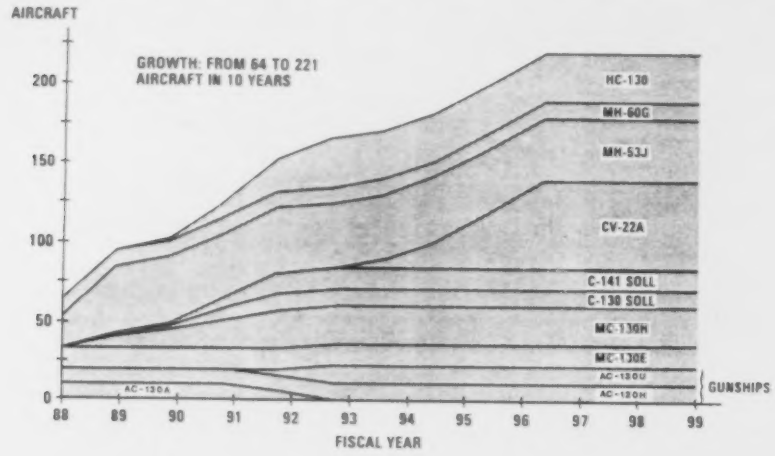

This is a tactical fighter road map at tab 30. You see on here F-16 and F-15E's, which are modified airplanes. ATA's and ATF's, those are the ones that have fairly recently gone through this process which we have taken you through today.

As I mentioned the other day in the classified hearing, the Air Force is committed to both of these programs. The Secretary of Defense was asked to certify that adequate funds were in the Air Force budget throughout the course for the ATA, and he did so. So you will see those in your committee.

For the ATA the Air Force airplanes will be in DEM/VAL in the fiscal year 1990 and that is what the money supports. We start full-scale development of the Air Force development in fiscal year 1991.

In the ATF, we complete DEM/VAL at the end of 1990, and in 1991 we start FSD.

## SOF INVENTORY



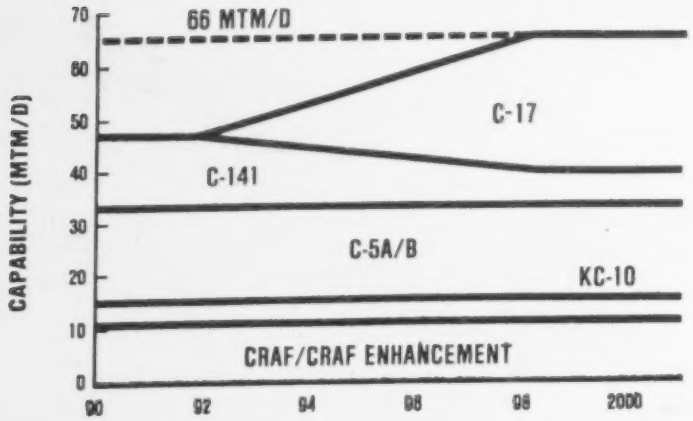

I think those are the highlights on this chart. If you will flip to the next one at tab 31, this is, toward the year 2000, what the special operating forces will look like, and this will continue the R&D efforts we have to meet the second level of our structure which was certified to Congress on the 1st of June 1987.

In the budget years, if we are discussing fiscal year 1990, if you look at the bottom of the chart, you'll see the AC–130U, the new gun ship. We start flying a prototype in April of 1990, and in fiscal year 1991 will complete the flight test on that airplane.

The Combat Talon II aircraft is 2 up on your chart. In 1990 and 1991 we will do integration of what we call the IDAS. Right above that, CV–22A is in 1990 and 1991, and we will be integrating the SOF unique avionics and systems, for instance, the radar and armament.

There is a system called Fast Rope for lowering troops to the ground, IR lighting and a special electronic warfare program.

## MEETING INTERTHEATER REQUIREMENTS




The next tab is 32. This is the inter-theater airlift requirement. Our RDT&E efforts here are centered around the C–17, and in fiscal year 1990 we complete assembly of the test aircraft. The first flight is in August of 1990. The avionics and software activities continue through that year. In 1991 we get the first life of durability testing and we begin our IOT&E, initial operational testing.

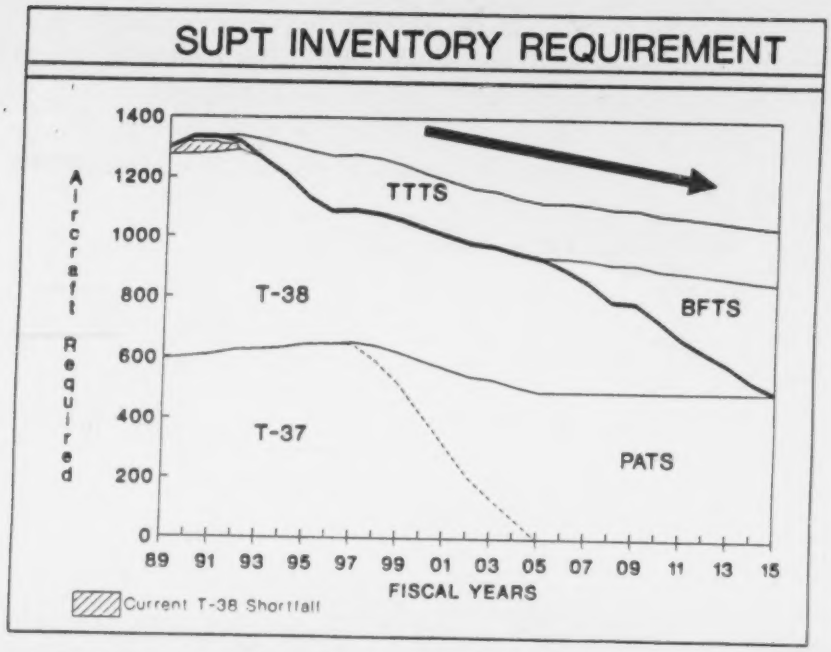
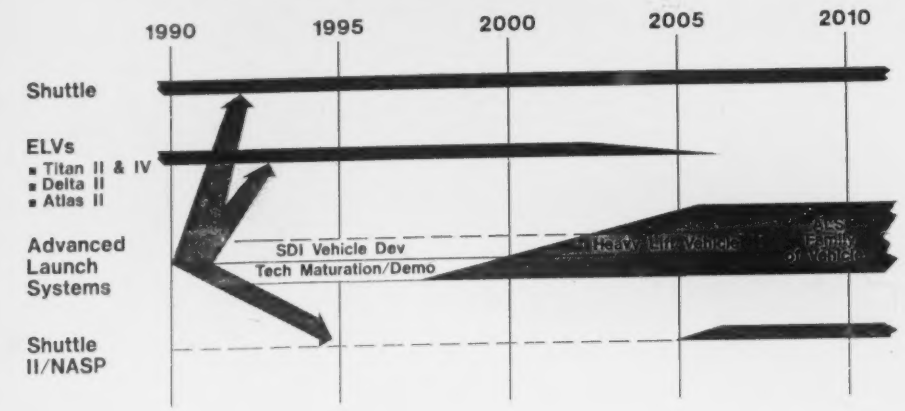



Chart 33 is support inventory, training airplanes. This is a joint road map which was developed by both the Navy and the Air Force, signed by Mr. Costello on the 15th of February of this year. It has also been signed by the Secretaries of the Navy, Air Force, and the Chiefs of the Air Force and the Navy, and it really lays out our training plans for the next 30 years.

What it shows is that we intend to buy a tanker/transport system which will enable us to enter a dual training system. That is off the shelf, so there will not be substantial R&D associated with it.

In the out years you will see that we will begin to bring in the T-37 replacement, which is the primary aircraft training system. You can see the dotted line there in fiscal year 1997 when that comes on, so the development and production funding will precede that, and the same for the bomber/fighter training system, which will replace the T-38, and you will see that that comes on line about the year 2006.

## Launch Strategy

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If you will go to the next tab, we talk about our road map for heavy boosters and launchers for our space systems, and the major point here is that through the 1990s we will be dependent, for most of our work, upon expendable launch vehicles—you see them listed there—and to some small regard, the shuttle, for those payloads which require men. What we are pointed toward is a family of vehicles, the advance launch system.

Now, what that holds for us is we hope to lower the cost to put an item in orbit to about one-fourth of what it is today. We want to get to blue suit operations. Right now it is a very labor-intensive and high-grade labor-intensive operation to launch a space capsule, a lot of engineers walking around in white coats. We want to get out of that mode and get into a more normal Air Force operation, not so high technology. We want to get faster turnaround, something we measure in days, and not months.

But what we are asking for in fiscal year 1990 is a total of about $406 million for boosters and for launch pads. We want to build a Titan IV launch pad on the East Coast; that will be our second. The budget also contains dollars for a second Titan IV launch pad on the West Coast.

We still have a process which is ongoing within the Department to decide specifically what pad at Vandenburg to use, the mothball shuttle pad or another pad, SLC–7.

For the last tab there, I will turn it back to Mr. Welch again.

# RDT&E ISSUES

| | SPECIAL HEARING DATE |
|---|---|
| • ICBM MODERNIZATION | NONE PLANNED YET |
| •• MOBILITY CONTRIBUTION TO SURVIVABILITY | |
| •• AFFORDABILITY AND TIMING | |
| • ATF/ATA | HASC - 1 MARCH |
| •• AF INTENDS TO BUY BOTH | |
| •• ATF PROGRAM PROPERLY BALANCED | |
| • SPACE BOOSTERS | NONE PLANNED YET |
| •• LAUNCH CAPACITY | |
| •• LONG TERM SPACE LAUNCH STRATEGY | |
| • ASAT | HASC - 15 MARCH |
| •• AF ROLE IN BM $C^3$ AND SPACE SURVEILLANCE | |
| •• MILESTONE I - DEC 89 | |
| • B-2 | HASC - 22 MARCH |
| •• PACE OF PROGRAM | |
| •• BREAKING GROUND WITH NEW TECHNOLOGIES | |

Mr. WELCH. The last tab we have come to, Mr. Chairman, you opened up the session saying there are several more specific hearings scheduled, we will address ourselves to those programs at that time. But we are prepared to answer questions today.

Mr. DELLUMS. Thank you, gentlemen, for your presentation.

The Chair would like to raise a couple of questions to begin with.

First, Mr. Secretary, of your $14.8 billion, how much of that request is for special access programs?

Mr. WELCH. I am going to have to give that number to you. It is quite a smaller number than it was in past years, in that we have removed several of the programs into the collateral secret budget.

So if I may, I believe we have a classification problem with some of that also. Let me supply that for the record, if I may, sir.

[The following information was received for the record:]

SPECIAL ACCESS PROGRAM

The fiscal year RDT&E total of $14.8 billion includes the Air Force SPECIAL ACCESS REQUIRED funding. The details are SPECIAL ACCESS REQUIRED and will be provided to the committee through SPECIAL ACCESS channels.

Mr. DELLUMS. As I indicated to you, the Chair has to gain experience with respect to what is important and what is not. Unfortunately, due to illness last week I was not able to be at the special access briefing, so if you can, please tell the subcommittee in open session what criteria you use to place a program in the special access category, as opposed to non-special access?

Mr. WELCH. I think the only thing I could say in an open hearing is that it has criteria within the total defense, and I think it has the status—as the status implies, it is one that has a very powerful

influence with respect to its results on our programs—programs of the United States.

Mr. DELLUMS. We will be able to go into that in more detail later then.

Mr. WELCH. There is a complete briefing which we could supply you that would show you the step-by-step process that goes into the closed loop to make sure that that process also includes all the appropriate audits and oversight that is appropriate.

General YATES. Mr. Chairman, we did that on the day you were ill. We will be glad to send the General over to go over that with you.

Mr. DELLUMS. Just 1 second.

Mr. Secretary, I have one other question at this point, and I would, at the end of my colleagues' questioning, raise some other questions with you.

In this present request, are you seeking R&D funds for an air-to-surface missile that could be dedicated to a NATO scenario, SRAM-T?

General YATES. Yes, sir, there are dollars in for SRAM-T, yes, sir.

Mr. DELLUMS. The United States and the Soviet Union signed an INF agreement which limits the surface missiles' distance and capability.

The question I have is whether or not pursuing the air-to-surface missile capability has the potential for thwarting the INF treaty, because while you are limited on the ground, you then develop stand-off capability that can fire the missile roughly the same distance.

Is that an appropriate area for us to pursue, given the developments of the INF treaty, or does that begin to complicate this process?

In other words, if I am limited on the ground from firing several hundred miles and then develop the air-to-surface capability which allows me to get around the strictures of the agreement, does that in one sense set it on its head or create complex problems for us?

Mr. WELCH. Let me ask General Yates to describe what it is doing first, and then I will direct my answer to your question.

General YATES. Sir, to begin with, it is not a comparable range missile. Let me make the point that the INF treaty is only applicable to ground-launched missiles. This is an air-launched missile. There is not a treaty now that would restrict an air-launched missile to less than 600 kilometers' range.

Mr. DELLUMS. I understand that perfectly. That is the basis for my question, should we be pursuing a program that gives us an air-to-surface capability that fills the void or the vacuum created by the limitation built into the INF agreement.

You have stated the point precisely, and it is in that area that I am raising the question of whether or not this is a serious dilemma. Does it create a problem?

Mr. WELCH. I would say to you, sir, that there is no dilemma in the process. The treaty, for good and sufficient reason, was very specific on what one should and shouldn't do and the relationships that resulted from such a treaty. It left other areas open to be pur-

sued as one normally pursues a defense against a threat. So I see no difference.

I think in the early part of this briefing we said in the acquisition community we observed all of the constraints, one of which we specifically noted as a treaty.

So I think, as you look at a threat and the menu of responses to that threat, if they are technologically capable and not constrained by some other paper, they should compete equally to see if they contribute to the defense of the United States that is being requested.

So I see no policy issue at all.

Mr. DELLUMS. Just one last thrust at that. If at the end of the INF process the agreement was that this was a political response and never was a military capability or requirement, why then are we now building in another military capability to solve a political problem that was resolved in INF?

If you proceed along the lines that say we don't have this capacity from the ground so let's develop the same capacity from the air, you still have not addressed the reality that the deploying of intermediate-range missiles was never a military response but a political response. Are we spending unnecessary dollars to solve a military problem that was never a military problem in the first place?

Mr. WELCH. I think you are beyond the area of where we pay attention to—to our particular piece of business here. I think I would be speculating for us to try to approach that in any way.

Mr. DELLUMS. I appreciate that. But this is an issue that we need to discuss politically, because I think this particular program has some implications down the road and I think we need to walk cautiously and dialog among ourselves.

Would the gentleman from Pennsylvania like to say something?

Mr. WELDON. In looking at that, we should also look at what attempts are being developed and implemented and researched now by the Soviet Union in the same category, because I think we have seen evidence that they are in fact pursuing the same line of movement you mentioned. So I think we should be looking at that, as well as what you said.

Thank you, gentlemen.

Mr. WELCH. I would say within the research and development program there is reasonable money to look at the technologies of verification and other things necessary to support such treaty arrangements. I think that is truly within the purview of acquisition in R&D.

Mr. DELLUMS. Thank you very much.

Mr. Darden is recognized for such time as he may consume.

Mr. DARDEN. I will pass at this time.

Mr. DELLUMS. Mr. Hertel. Mr. Dickinson.

Is Mr. McNulty here? Mr. Pickett?

The gentleman from Virginia is recognized for such time as he may consume.

Mr. PICKETT. Thank you, Mr. Chairman.

How does the Air Force go about coordinating what you learned in the basic research 6.1 category, with what the Army and the Navy are doing? Perhaps the Department of Defense is going on its own in this same area.

Mr. WELCH. There is a formal operation that is overseen by the Deputy Under Secretary of Defense for Science and Technology, where each of the groups meets once per year for a several-day forum session to make sure there is no duplication in that process. It is again reviewed when each of the military services submits their budget to the Department of Defense.

On almost a day-by-day basis, I would tell you that the majority of the laboratory directorates of are looking for the duplication, as an audit process, as well as looking for the complementary process where people are finding things in one laboratory that can support others.

But I think it is an all-year type of thing that is formally audited and reported once by the Department of Defense. In fact, we refer to it on tab 8 or chart 8 in the book that you have.

We also look beyond the Department of Defense, looking across to the National Academy of Engineering and Sciences and trying to make sure if we can get some assistance into new areas that may have been looked at in the commercial world or other worlds.

Mr. PICKETT. When you have a program that draws considerably on the 6.2 and 6.3 areas, for example the F-117 program was developed on the leading edge of technology, and we have a follow-on program like the B-2. How much effort is made to make sure that the lessons learned in one program are applied in the other?

Mr. WELCH. Without going into the specific way—because I think some of the areas are classified—I can tell you that there is a very structured area, from our highest level of classification down through unclassified, to make sure that those are transferred.

We will be happy to answer you directly for the record on that.

[The following information was received for the record:]

The details are SPECIAL ACCESS REQUIRED and will be provided to the committee through SPECIAL ACCESS channels.

Mr. WELCH. Certainly if you think of it in a generational way, if perhaps you think about the SR-71 as a first-generation of low observable technology, and you go up to some of the cruise missiles and then up into the F-117 and then on up into the B-2 and beyond, I think you can see that we are managing that and transferring that technology on a generational basis.

I think we could demonstrate that to you adequately in a different forum.

General YATES. I would add, sir, that the way you do that most effectively is by having an interchange of knowledge between the people who are working on the programs, so that, for instance, those people who are working the Stealth-type issues on the ATF get cleared, the technical people get cleared on the same applicable programs for the B-2 and for the F-117, and in fact some of the technical people move between programs in the same area. So we work that program very hard.

Mr. WELCH. There is a repository of data that is captured and made available. It is a contract activity that we specifically include as a part of each of the things we are doing, provided we are not into an intellectual property right situation.

Mr. PICKETT. The reason I am pursuing this is because there were two different companies involved in the two different aircraft

programs that I have just mentioned, and I was led to believe that there was very little opportunity for the transfer of experience and knowledge gained in the earlier program to be able to apply in the latter program. That is why I was wondering if there is some structure arrangement to do that, so these contractors are not required to go back and re-invent the wheel each time.

Mr. WELCH. Which were the two that you spoke of?

Mr. PICKETT. The F–117 and the B–2.

Mr. WELCH. I think there is perhaps a two-way street on that. I think there was quite a bit of transfer from the 117 to the B–2. I am not sure it went back the other way.

Mr. PICKETT. Timewise I would see how it would not. But my information, spurious though it is, led me to believe that there was very little gained by the latter program from the former program.

Mr. WELCH. There is a very formal process and we would be happy to share that with you.

[The following information was received for the record:]

The Air Force has already provided that information to the committee through SPECIAL ACCESS channels.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. DELLUMS. The gentleman from Pennsylvania, Mr. Weldon, is recognized.

Mr. WELDON. I want to thank both gentlemen for coming and appearing before our subcommittee this afternoon.

My first question has to do with the ICBM modernization. The administration has pushed back its date of announcing its decision on the MX versus Midgetman to, I believe, April 1. Is that what your understanding is?

Mr. WELCH. Yes, sir. I think there are two pieces that you have to keep in mind. There is a strategic modernization study that is going on, but I am not sure that that isn't a little bit later date. The specific was that there would be a decision made on how to spend the unused funds from fiscal year 1989 that were fenced—originally assigned by 1 April.

Mr. WELDON. There has been a discussion of research, regarding the possibility of a consensus coming out to move ahead with both rail garrison and the Midgetman. This will have major implications from a funding standpoint for us as we face the very real potential of a flat defense budget for the next several years.

I would like to have your comments, now or for the record, on your views from a fiscal perspective as to whether or not you feel we can afford to develop and deploy both programs in the event or the likelihood of the budget problems I have outlined for you.

What would the annual cost be approximately over the next 4 to 5 year period of time, which you cannot provide today, but you can for the record, and how might the schedule of the programs' implementation be affected if such a consensus arrangement were in fact pushed forward? What is your reaction?

For the record, I think it is important that we get these issues on the table now and get your comments, either here or on the record, so that we have this information when the debate emerges on the floor of the House or in this committee.

Mr. WELCH. I will make several comments on that.

I think, to start with, it has been clear for some period of time that the Peacekeeper Rail Garrison, the Small ICBM programs, from a technical acquisition/performance standpoint are good programs. No one was choosing between them on the basis of which was the better; they are both very good and very adequate. So from the RDT&E standpoint that we are addressing today, I think those options remain.

The discriminating that has been discussed in past years is truly with respect to the budget that you talked about, and the least expensive vehicle that was judged to do the job was selected. Beyond that I think one can have infinite options, since they are both technologically able in other ways.

I think we must wait until the end of the strategic modernization review and see what their total contribution to deterrence is, and then I don't believe the acquisition community will be binding on that in any form or fashion.

Mr. WELDON. I understand what you are saying.

For the record, I would like you to provide for me what estimates you could over the next 4 years, assuming that this consensus arrangement is being pursued. I don't expect you to do that today.

[The following information was received for the record:]

FOUR YEAR ESTIMATES

Mr. WELDON. I understand what you are saying. For the record, I would like you to provide for me what estimates you could over the next 4 years, assuming that this consensus arrangement is being pursued. I don't expect you to do that today.

Mr. WELCH. We will be happy to provide you 4 years projections on our ICBM Modernization programs. However, since the President has not made any final decisions on this issue, we have no new information to provide. When the decision is made, we will provide the data to you and your staff.

Mr. WELDON. Go ahead.

Mr. WELCH. If you could help us, also, you need to tell us when you want them available, and then that goes with an expenditure curve, because again that will be what sizes of those budget discussions you must have.

Mr. DELLUMS. Would the gentleman yield?

I appreciate the thrust of the gentleman's question. As you recall, as the debate has emerged on Midgetman and MX, that the proponents of Midgetman suggested that a single warhead missile would be a less attractive target, so if you follow that argument all the way out, the two programs are going in two different directions.

Would the gentleman pursue that area?

Mr. WELDON. Yes, if we could.

Mr. DELLUMS. The one is a multi-warhead, more attractive target——

Mr. WELCH. Again I believe the technological opportunities to move to things that were perhaps favorable in INF but not favorable to START and to recognize the missiles, the warheads and the basing can all be made available, depending upon the deterrence matrix that you wish to fit them in.

But I see no acquisition limitations with respect to the two prime candidate systems talked about, including the opportunity to look at the front end through the existing Minuteman force.

Mr. WELDON. But the dollar decisions that we have to base our votes upon are going to be based upon input and data that you provide to us, developed along with the research that has been carried out with both programs.

General YATES. I would just add in that vein—and we will do as you ask and provide the specifics—but the argument is really not one of capabilities, but it is really one of dollars.

In that regard, I believe the only argument that is proper to focus on is what remains to be done. What is behind us is in fact something that we should take advantage of. The consensus that we are hoping for is clearly one that leads this Nation to have mobile ICBM's, and the Peacekeeper is about $5.4 billion to mobilize, those that we have in silos already, and can be mobile with an initial operational capability in fiscal year 1992.

Mr. WELDON. But we have to fund that which you are talking about, and that is the data that we will need.

Mr. WELCH. I think it would not be proper to stop at this point without saying that the reason we have these many options available with high probability of success is because of the R&D investment we made previously, and we would like to continue that level of investment to keep even more options available in our advanced systems programs in the ICBM modernization area, too.

Mr. WELDON. Thank you.

I have two other areas that I want to pursue.

On the acquisitions program, a program that I am very supportive of and that this committee is supportive of, in last year's budget the Senate eliminated $88 million of continued funding for the improvement program for AWACS.

What impact has that reduction in funding had on the AWACS modernization program currently under way?

Mr. WELCH. Let me try to start that. The modernization in terms of improvement in radar capability, we have structured a program and we are proceeding with it. I can't give you the specific impact of that $88 million.

I can tell you that the program is proceeding and——

Mr. WELDON. For the record, I would like to know what impact that $88 million loss has caused the program, if you would.

General YATES. Yes, sir.

[The following information was received for the record:]

AWACS IMPROVEMENTS

*Question.* For the record, I would like to know what that $88 million loss has caused the program, if you would?

Answer. The Congressional reduction to AWACS Improvements funding for fiscal year 1989 totaled $55.8 million. The cut was against the Radar System Improvement Program (RSIP) in the RDT&E account.

[Deleted.]

RSIP is strongly supported by the Air Force, the CINCs, JCS, and the OSD.

Mr. WELDON. The last question is the avionics package that we are developing in several different programs, such as the B–1 and B–2, among others. My gut feeling is, with the increased cost we are seeing in the packages, what degree of coordination is the Air Force pursuing with this?

I am not totally satisfied that we are aggressively pursuing coordination as we should be, given the rapidly increasing costs of the system.

General YATES. You mean coordination with the other services?

Mr. WELDON. Yes.

General YATES. We are pursuing this with an absolute vengeance. We are very proud of where we are. As a matter of fact, if you look at where we are, we have not yet missed one of our milestones—the set of milestones which, when we laid them out, knowledgeable technical people said we couldn't achieve.

Not only important in terms of milestones and looking at hardware and software development, but more importantly and to the point of your question is how we are standardizing to what we call accommodating the avionics baseline, which would lead to common specs in the services, common specs with which we can work with industry. So that we are bringing industry along with the concomitant capability to produce the types of things we are in fact expecting, we have come out with what we call Common Avionics Baseline II-B, and that was done on schedule in January.

We look at the end of this year to having what we call Common Avionics Baseline III. The significance is that it is what we will go into fullscale development (FSD) with. So the Navy, the Air Force and the Army are in this together every step of the way. We also have gotten industry advice.

So I believe what has been laid out is being followed just as we have briefed the Congress on many occasions, that we are following it to the letter.

Mr. WELDON. OK. Thank you.

Mr. DELLUMS. Mr. Kyl is recognized.

Mr. KYL. Thank you, Mr. Chairman.

First of all, let me go back to the ICBM program. One of the concerns has been the possibility that the rail garrison of the ICBM might result in sabotage and other kinds of problems that could occur, that we might identify through some kind of a red team analysis. We understand that there has been a modernization advisory group looking at that entire issue.

Although their work is very classified, I would like just to elicit one answer from you, and that is whether or not that program has so far identified any significant obstacles, any show stoppers, in terms of the survivability of the garrison system.

General YATES. The answer to that, sir, is no, we have not. We will be happy to give you a classified briefing, if you would like.

Mr. KYL. I would appreciate that, Mr. Chairman.

Mr. DELLUMS. We appreciate that, if you would supply that for the record.

[The information is being kept in the committee files.]

Mr. KYL. There has been discussion of the Small ICBM costs. I would like to ask you several questions about that.

First of all, if you could, give us the latest figures for the total cost of the baseline small ICBM program, and if you would express that in terms of 1988 dollars and then other dollars, I would appreciate it. For 500, for example.

Mr. WELCH. Right now you would like that?

Mr. KYL. Please.

Mr. WELCH. The number for 500 Small ICBMs right now is $23.6 billion in this year's dollars.

Mr. KYL. Can you give me the end year numbers?

Mr. WELCH. That is fiscal year 1988 dollars, because that is the way I have made this chart up here.

Mr. KYL. OK.

Mr. WELCH. I do not have it in then year numbers.

Mr. KYL. How about for 300, if that were to be the number instead of 500?

Mr. WELCH. It is $17 billion in fiscal year 1988 dollars.

Mr. KYL. Thank you.

Can you give us the rail garrison rebasing of 50 Peacekeepers, please, in 1988 dollars?

Mr. WELCH. $5.4 billion. I am giving you only acquisitions costs now, not life cycle costs.

Mr. KYL. I understand that.

There has been some suggestion that the cost of the Small ICBM program has been reduced.

Could you tell us what has caused that cost reduction?

Mr. WELCH. I think as time goes on we have been more successful in our development program and we have had a better opportunity to look it over. I think it is a very natural evolution where confidence can be increased.

We have looked at the program each year. I could give you a list of all the various changes and things where we perhaps were too pessimistic to start out with.

General YATES. But in general we haven't had any problems in the test program. There has been a reduction in the number of tests that have been required. Some of the advantages that we see we can get from competition are greater than we had originally anticipated.

So it is all favorable things, things that have been done right in order to lower the cost.

Mr. KYL. These costs are not because you considered it a two-warhead as opposed to one-warhead missile; is that correct?

Mr. WELCH. All the costs that I spoke to you about are the basic 37,000-pound, one-warhead missile.

Mr. KYL. With respect to the option of going to two-warhead, 37,000-pound or 45,000-pound, is it the Air Force's position that that is a preferred or viable option?

Mr. WELCH. The 37,000 lb. and one-warhead we would believe to be a starter.

Mr. KYL. Can you be any more specific about that?

Mr. WELCH. I would just as soon not.

Mr. KYL. OK.

Now, finally with respect to the line of questioning that Mr. Weldon was pursuing, I would like to ask you some questions about the cost of proceeding with both.

The Chairman was quick to point out that to some extent we are talking about two different programs here and we might have different opinions as to whether one was better than the other, but there has been some talk about having both.

I would like to ask you whether or not it is your view that both programs could proceed at the same time or whether in our flat

budgeting time right now that would be very difficult for budget considerations.

Mr. WELCH. Technologically they were scheduled to proceed and were proceeding at the same time. I think the structure of the program that one might wish to proceed on would set the budgetary limits, but from an acquisition standpoint the programs were going that way.

So I think the answer must be yes.

Mr. KYL. My question was purely couched in budget terms, given a presumably flat budget situation.

Mr. WELCH. Well——

Mr. KYL. Can we afford to develop both programs simultaneously, given our flat budget situation?

Mr. WELCH. From the standpoint of looking at the Air Force, certainly.

Mr. KYL. I am sorry?

Mr. WELCH. Certainly.

Mr. KYL. Where would you take the money from?

Mr. WELCH. Sir, you will have to tell us. You just asked me should they proceed from a deterrence standpoint.

Mr. KYL. No, I asked you if you could do it from a budget standpoint.

Mr. WELCH. I answered from a deterrence defense standpoint.

Mr. KYL. Both of these programs, if they were to be redeveloped—instead of rebasing the rail garrison, which is $5.5 billion, we are looking at $17 billion or $23 billion, and whether we wanted to add 300 or 500 small ICBMs. You said technologically that is very do-able and both missiles are fine weapons, but you would leave the question of the financing and where we would get the extra money to us, you wouldn't have a recommendation on that?

Mr. WELCH. I would like to see the President's strategic review and I believe it will be his budget that will show it to you.

Mr. KYL. I understand. That is due on April 1 and we are trying to understand how to be able to evaluate what he gives to us, and that is the purpose for the hearing here.

Mr. WELCH. We can give you the cost options to schedules and the technical risk. Beyond that, trying to make broad-based budget decisions, I don't believe is our purpose in life here.

Mr. KYL. I understand that, sir. Getting ready for the April 1 decision, you must have some numbers now on an annual basis—say, for the next 4 or 5 years—or what you would be asking for above just the price of rebasing the 50 MX under either of the 300 or 500 small ICBM options.

Do you have those numbers?

Mr. WELCH. We can provide certainly a representative set of numbers.

[The following information was received for the record:]

REBASING THE 50 MX

Within the FYDP, the required funding profiles for the Small ICBM program, with a 1997 Initial Operational Capability, are identical for both the 300 and 500 missile options. The required funding profile in Then Year dollars is: Fiscal year 1990—$100.0 million; fiscal year 1991—$200.0 million; fiscal year 1992—$538.0 million; fiscal year 1993—$574.0 million; fiscal year 1994—$735.0 million.

Mr. WELCH. I think, as you have illustrated from your questions, the number of warheads basing size of missile, IOC——

Mr. KYL. 35,000 pounds—excuse me, I will ask the question very specifically.

One warhead, the basic missile that you are talking about 37,000-pound, each and purchasing either 300 or 500 of them. What are the numbers?

Mr. WELCH. Those were the numbers I gave you from an acquisition cost standpoint.

Mr. KYL. How about an annual number? You were saying, in terms of the total budgetary question, that you didn't want to get into that. I am saying over a 4-year period you must have the numbers to help the President reach the decision by April 1.

Mr. WELCH. I believe—and I would like to have a chance to correct this for the record—we would have to modify fiscal year 1989 and put $175 million roughly into the Small ICBM, and I believe the number for fiscal year 1990 is $500 million. I have not looked beyond that. We can give you the next 2 years, if you wish.

Mr. KYL. I would appreciate that. That is for the 300 or the 500 number, or does it really matter a whole lot?

Mr. WELCH. That is for the 500 number, but in those years it possibly will not matter significantly.

Mr. KYL. I appreciate that. That is a helpful answer.

If either one of you would like to comment in response to your point when you and Mr. Weldon had your colloquy, there are two different ways of looking at this question of R&D on follow-on weapons, which may have some relationship to weapons that we eliminated in the INF treaty.

I can remember that one of the arguments for the INF treaty and the elimination of the Pershing II missile was that you don't have to worry because we have other weapons that can cover this same need. We have our ALCMs and SLCMs, so even though we will get rid of a significant body of weapons, an entire class, you don't need to worry because we have other weapons to do that job.

It is my understanding—and the gentleman can correct me if I am wrong—that the R&D is simply for the follow-on of those existing weapons, so it is very consistent with the arguments that were used to sell the treaty.

General YATES. I think that is true.

Mr. DELLUMS. I appreciate the gentleman's comments. I plan to go back and ask similar questions.

Mr. KYL. Is that a suggestion that I had better stick around to the end of the meeting?

Mr. DELLUMS. The time of the gentleman has expired.

Mrs. Byron.

Mrs. BYRON. Thank you, Mr. Chairman.

Mr. Secretary, one of the things concerning the F-16 upgrade, which I think appears to represent about $1 billion development effort—how much will our allies pay for this development and the increments involved that we are getting from this investment?

One of the things that concerns me that we have seen, and I am not sure how much we have gone into that area on R&D, but on your tab 24 you have human systems technology. It seems to me that recently in many of the cases we are beginning to find a

thread that seems to say we have overdeveloped the capabilities of the F-16 as far as the capabilities of the human element is concerned.

I am concerned about an aircraft that we are beginning to find can outfly our pilots.

How much R&D are we putting into looking at the human factor? Is any of that funding on the F-16 upgrade to go to look at making the human factor a better formula?

General YATES. First, I am very familiar with the F-16 and I have spent about 5 years of my life working on the airplane and flying it.

I don't agree with the premise that the airplane is outstripping the pilot. Clearly, in any high performance modern fighter you must very carefully consider what the limitations are of the pilot, and you have to be, just as you are suggesting to us, very careful about the human factors.

Whenever we put a new system in the F-16, any of these upgrades—let me give you an example: the LANTIRN system. When we integrated the LANTIRN into the airplane, a major portion of what we had to do as far as development, we call integration. A major portion of that is in fact just what you are getting at, Mrs. Byron, to make sure that the pilot interfaces with the system.

In fact, it is one of the things that makes the flight test cycle fairly long, because you have to expose it to a number of people and a number of situations.

That is not where it started, though. It started with our development usually in simulators so that we can look at all the human factors. So there is a lot of attention which goes into the pilot's capabilities and his limitations in putting anything in the F-16.

Mrs. BYRON. We have projected about $1 billion for upgrade.

Is that all coming out of our budget or are any of our allies who are using the F-16 contributing?

Mr. WELCH. Are you speaking of the F-15E or——

Mrs. BYRON. F-16.

Mr. WELCH. As you are aware, anytime we sell that program to anyone overseas, there is an R&D recoupment that is involved with that, and also a special relationship with a multi-national group that has been on the early part of the F-16 program from day one in terms of recoup value.

Mrs. BYRON. In this time and day when we are hearing so much about burdensharing, I guess I really am concerned about whether we have anybody else helping us to upgrade any of the aircraft that we have, not only foreign sales but joint agreements.

General YATES. Mrs. Byron, as Mr. Welch said, ordinarily what happens in these things is that we sell and then recoup, but on the F-16 program in particular we do have a close relationship with foreign European nations—Belgium, Denmark, Norway and The Netherlands—and we are considering entering a co-development program with them for a future version of the F-16 and some upgrades that we have.

Now, that hasn't been finalized, but if we do that, for sure they will share the development costs of those systems.

Mrs. BYRON. So the answer to my original question, whether our allies were going to share in those developments costs, was yes?

Mr. WELCH. If I may, I will try to answer your questions on Human Systems Laboratory, although obviously it is not all dedicated to just the cockpit. It covers everything else.

Their budget for their own technological base for in-house activity is about $50 million per year.

Mrs. BYRON. OK. The tab number 33, where you talk about our training capacity, I notice that you have the T-37 going down fairly dramatically in the not too distant future.

Are there funds in this budget to look at development of a new trainer?

Mr. WELCH. AS a replacement trainer for the T-37? It is outside. It would be right at the end of this budget time period. The T-37 is presently going through a service life extension program, which we believe will take it down that dotted line.

Mrs. BYRON. How much does it cost to develop the T-46?

Mr. WELCH. I have to answer that for the record.

[The following information was received for the record:]

T-46

Mrs. BYRON. How much does it cost to develop the T-46?
Mr. WELCH. The Air Force spent $285 million to develop the T-46 aircraft.

Mrs. BYRON. Thank you.

I guess it bothers me that we go along in development when we have a need for a new trainer. We then get into some problems, the Department of Defense and the Air Force owns the plans and proposals for the T-46. It seems to me that the logical thing was to re-work those and put them out on bids for another contractor to take a look at it as opposed to starting from square one all over again when we have an engine that was developed for that trainer to meet the needs.

I understand that those plans are available and it has not been completely ruled out.

Mrs. BYRON. If you will submit that for the record, I would appreciate it. Thank you, Mr. Chairman.

Mr. DELLUMS. Mr. Hochbrueckner.

Mr. HOCHBRUECKNER. Thank you, Mr. Chairman. On the B-1 Bomber, as you know this committee in its reports has indicated that we felt a major source of the problems on the B-1 was related to the fact that the Air Force elected to be its own systems integrator.

As you know, with the offensive and defensive avionics, it is a very complex package in both areas, and while the Air Force has done a superlative job on missile programs, it appears that in retrospect that the Air Force selecting to be its own integrator was a major source of the problems we have seen with the B-1.

In the language of the reports and in other language that we promoted, we have been in essence directing the Air Force to still go out and find a systems integrator, someone responsible for the completion of the flight test and bear the brunt of any further problems.

Has anything gone on in this area in terms of finding a systems integrator or is the Air Force competing to be its own manager in this area?

Mr. WELCH. First I would say that we would agree with your first comment with respect to not wanting to take system integration in a proposal like that.

At the stage we are on with the B-1 right now, the remaining system we are addressing ourselves to is the defensive of the avionics system.

We believe that we have an approach that will satisfy the use, the user's needs and that is in line with the various studies that were done last year. With respect to its continued user, we can continue without a system integrator, but we would be happy, certainly, to hear from someone that believes that they could make a contribution in that area at this late stage, keeping in mind we still have a challenge of completing the contract of the present defensive avionics contractor.

Mr. HOCHBRUECKNER. So nothing has changed in terms of management in essence. Has the Air Force decided exactly what to do about upgrading the Electronic Countermeasure (ECM) system? Will the ALQ-161 be upgraded or will you not have a penetrating bomber?

Mr. WELCH. Our position is the same as sometime past; we will capture the core capability that has been demonstrated in the ALQ-161 and we have looked at alternatives, and are in the process of running an evaluation this year of those alternatives.

One alternative of which we have received proposals in terms of upgrading or completing the contract on the 161 as an option.

Mr. HOCHBRUECKNER. Is there any money in fiscal year 1990 for that upgrade? Is there any money in the fiscal year 1990 budget to upgrade the 161?

Mr. WELCH. Yes, although just for a radar warning receiver to augment the "CORE" ALQ-161.

Mr. HOCHBRUECKNER. Would you know offhand how much? Approximately?

Mr. WELCH. I believe approximately $46 million, and that was based on the funding that we have identified if we were going to upgrade using a radar warning receiver. We have not had an ALQ-161 upgrade proposal that has been technically acceptable yet with respect to being able to look at the funds that might be required for upgrading the ALQ-161.

Mr. HOCHBRUECKNER. Is there any ASAT money in the Air Force RDT&E budget this year?

Mr. WELCH. ASAT?

Mr. HOCHBRUECKNER. Yes.

Mr. WELCH. In the—no.

Mr. HOCHBRUECKNER. OK. Actually, to follow up on the previous question, on page 33 of your prepared testimony covering your T-37 and T-38 replacement, when one looks at the paths and the deep FTS and TTS, you had indicated there is no money in fiscal year 1990 for funding of the replacement for the T-37 or T-38?

General YATES. Correct.

Mr. HOCHBRUECKNER. Are you in a position at this particular time to describe what the FSX agreement is shaping up to be with Japan, or should that be the subject of a different hearing?

General YATES. I can talk about it a bit. As you know, there is an interagency review going on right now. I think that there are a couple of points of dispute about things which should be released.

Mr. Hochbrueckner, they fall in the software area. We are not talking about things which have to do with basic aircraft structure or aerodynamics, or electronic equipment. Those things have been resolved, I believe, to the satisfaction of everybody.

That can come back up, I realize, at any point. But we are down to the point of talking about software codes in a couple of computers. So I think the major issues have been resolved as far as what is releasable.

The program is about a $1.2 billion development program. We are looking at about 40 percent of that work coming back to the United States.

So that is sort of the status of that right now. Is there anything specific I can delve into?

Mr. HOCHBRUECKNER. It sounds like we should have a discussion separately on that.

Next area I have been getting very heavily into real time signal detection and analysis. I would appreciate for myself and for any other members who might be interested if you could arrange for a briefing on that. I would like to know where you are in that area.

Along those lines, as you know from the last couple of years, I have been promoting a program called x-ray lithography, a second follow-on the VHSIC technologies. So that we are talking about computer chips with element sizes the quarter of a micron. For the last 2 years, Congress has appropriated funding to kick off the program. Unfortunately this year there is no money in the budget. We needed $44 million through DARPA to continue the program. I was wondering, since the Air Force would obviously be a major beneficiary of x-ray lithography devices, would it be of any benefit to package the program in smaller amounts, if indeed there was any interest on the part of the Air Force. Would you happen to have any money squirreled away somewhere that we could dedicate to x-ray lithography?

Mr. WELCH. We have none squirreled away. We would be happy to answer you—[laughter]—I would have to answer that for the record. We would be pleased to come back and talk with you.

Mr. HOCHBRUECKNER. My last question, coming as an ex-navy person myself, I have a great deal of difficulty with taking an Air Force ATF and putting a tailhook on it and making it into an ATTF. I recognize that you gentlemen have a tremendous amount of experience with the Air Force and you have been around through the F-111 and other programs, philosophically, how do you feel about putting a tailhook on it and trying to put it on a carrier? I mean you are in good shape, you have the ATF.

My concern is what should the Navy be doing?

General YATES. I think this is a thing which has been tried in the past without any success. So we will not do it that way. What we look for is that the Navy airplane will be a variant.

We will have as we talked earlier, with other Members of the committee, common avionics. We will have common engines. We will have common subsystems. But the airplanes at the mold line, will probably not look the same. I would not think that the high

lift features on the wing would be the same nor would I think that the nose structure would be the same for visibility.

So where we are going to get the commonality out of these programs is at the levels that I mentioned, and those are the high cost drivers on the airplane, avionics, engines and subsystems.

So I would look to see, from a cost point of view, somewhere in the neighborhood of 60 percent or up commonality between the airplanes.

But we are not going to make the mistake that you are describing, and try to make one airplane do two different things.

Mr. HOCHBRUECKNER. [Presiding]. I am sure the Navy thanks you for your comments. Thank you, Mr. Chairman. Mr. Dornan is recognized.

Mr. DORNAN. I just have a few clean-up questions. It is a long evening. I don't know if there will be ice on the way home. On tab 30, for the Air Force program, I assume that FWW means follow-on Wild Weasel. It doesn't have it coming on until late in the year 2001. Are we actually going to nurse those F-4-Gs that are at George Air Force Base for another 12 years before we get a replacement?

General YATES. We have just entered as we described in the briefing earlier, Milestone Zero, this last year for follow-on Wild Weasel. So I believe that at this level on this chart you should consider it as something that is completely notional. The truth of the matter is that we don't know yet. We are in the structured process of determining exactly what we are going to do, but it is going to be an out year replacement, that is clear. But I don't know that while we show that on the chart, I really don't know if it will be a few years earlier or not.

But the Air Force is still looking at the F-15-E. I see some discussion about looking at the European Tornado.

General YATES. At this point, for this Milestone Zero exercise, we have not closed out anything. So it is wide open.

Mr. DORNAN. Great. Then another quick question on the FSX. I had some three-star Air Force generals say that if anybody goes to the House floor to defend the FSX technology transfer to Japan on the basis that we are going to get something back from them because they are ahead of us in avionics—to forget it. We are not going to get anything from Japan in avionics.

There are many Members who believe that there is some sort of a high technology exchange here. I was told we should approach the program on its merits, that it keeps Japan tied to us as an ally and prevents them from going somewhere else.

Did you say that 35 to 45 percent of the avionics alone will be made in this country?

General YATES. No, sir. I said 40 percent of the development programs. It is still to be decided, but the memorandum of understanding anticipates 35 to 45 percent.

Mr. DORNAN. Is that a general Air Force feeling? That there isn't much to be gained—if anything at all. That we are not the leader, and that we are not going to get any great Japanese miniaturization. It will not be a home video cassette recorder situation?

General YATES. First, I think the basic premise of what you said is right-on. I think a lot of people have lost sight of why we set out

to do this and in fact, it was berthed in a national security context and in fact to get Japan to do more burdensharing to help us with the defense of the Northern Pacific Rim—that was the basic reason for doing that.

We shouldn't forget, and I am sure you are aware, that you started out with Japan wanting to build their own airplanes, then with our persuading them to produce a variant. Now, I think that part of your comment is well-spoken.

General YATES. As far as the fact that what we can get out of this, there is a technology in which we would be hopeful in avionics to get from the Japanese. We are looking at active element phased array. We know how to do that in this country. But we have not been successful in finding a way to produce those to bring the cost down to an affordable realm.

The Japanese intend to have an active element phased array radar on their FSX, which says they intend to invest money and resources and their manpower and find a way to solve that problem. If they found a way to make those elements producible on a large scale, that would be a great value to this country.

Mr. DORNAN. That is almost more an engineering value that they would pass on along with some technology——

General YATES. I think I could characterize it as a manufacturing breakthrough rather than a technology breakthrough, but nevertheless, very valuable to us.

There are arguments people would say that they are not going to be able to do that. Maybe they can't. If they can, there is certainly a lot for this country to gain from it. If they can't, then I would suspect if they are going to build the airplane on the time frame that they say, the logical place to come if they fail to do something planned in the program, it is back to us.

Mr. DORNAN. There is a school of thought that feels if this arrangement with the Japanese falls apart, there is a group in Japan that would be too happy to go somewhere else or develop it on their own, given their Government funding situation?

General YATES. I am certain you are correct because that is the way they started.

Mr. DORNAN. One other quick follow-up on the ASAT, zero dollars in your budget. Because you gentlemen also track Soviet threat, there is continuing ASAT money.

Mr. DELLUMS. Would the gentleman from California yield briefly?

I think this is an appropriate point where I would like to yield to staff so they could clarify the funding for ASAT.

Mr. BAYER. There is money for ground base lasers.

Mr. WELCH. I was referring to no dollars to the program last year. There are elements of technology on ground base lasers in the laboratory. There are obviously items that support ASAT in surveillance and battle management $C^3$, etcetera.

There are dollars in there for those.

Mr. DELLUMS. I appreciate my colleague for allowing me to intervene.

Mr. DORNAN. I don't mean to be provocative, but the Soviets have plenty of ASAT money, not only in their operational budget,

but in their acquisition budgets for future programs as far as we can tell, correct?

Mr. WELCH. They have an operational capability. I can't comment on their acquisition budget.

Mr. DORNAN. They product improve everything they have; correct?

Mr. WELCH. I think that is better discussed in another forum.

Mr. DORNAN. I agree.

On the B-l, I had the opportunity to go to dinner with some retired electronics people at Fort Myers. By sheer coincidence, truly not by design, I had three retired members who served for the integrator team for the Air Force on the B-1. I took that opportunity to discuss in detail the defensive electronics problems.

I had just seen on a national Sunday morning show, Leslie Stahl's "Face the Nation," an interview with the distinguished Chairman of the Senate Armed Services Committee. He let Leslie Stahl get away with saying to his face that it is foolish to be building two bombers, B-1 and B-2.

Why did he allow that to go on? Why did he, as Chairman of the Senate Armed Services Committee, ever permit the B-1 to come on the line when it simply wouldn't fly? Then she said, they are falling out of the sky, obviously indicating the bird hit, a pilot error landing approach accident, and an engine fire.

He let her get away with it. I said you people are crazy. To say an airplane wouldn't fly would be like a problem with a Norden bomb site air flight B-17 or a B-24 and saying the plane wouldn't fly. The Liberators or B-17s are failures because of a glitch in the bomb site which was then the simple state of offensive electronics. I asked this retired general—I am sure you both know him—General Marks, a question on the factor of complexity of defensive to offensive electronics, "Would you say in this day and age that the defensive electronics are a factor of maybe 10 to 1 more difficult than the offensive electronics?"

His answer was, "Congressman, how about 100 to 1?" I asked for a round-table, and they agreed. I think it is good for Members to know that the engines are fine. We are using the CORE in follow-on projects; that the air frame is fine; that the Boeing team on offensive electronics is fine, but Eaton's job is 100 times more difficult than Boeing's working out the defensive electronics.

My question is, and I think you have already said it, but I want to get it straight, how much money is in the budget for working out those 100 to 1 times more complex problems with the Eaton defensive electronic systems in the B-1B? How much money in the 1988 current fiscal year budget and how much for 1989? 1990?

Mr. WELCH. I believe through 1989 there is probably about 36 million in R&D for the "CORE" program with EATON.

Mr. DORNAN. Starting October 1 of 1989?

Mr. WELCH. That is fiscal year 1989. Starting fiscal year 1990 we had approximately $46 million that we were looking for. But this request is for a RWR to augment the "CORE" ALQ-161 system.

Mr. DORNAN. That's what I thought.

Mr. WELCH. That is not necessarily going to Eaton to fix the ALQ 161. That is a program to look at options to go beyond the CORE capability of the ALQ 161. One cannot conclude what the solution

is to do that right now. We are in a two-step process. We are capturing that capability which exists in the aircraft today and tested on what is called a CORE capability.

Then we are evaluating several schemes to go beyond that capability. Frankly, the one which we favor right now would be an addition of a radar warning receiver. That is what we used to price that part of the budget.

Mr. DORNAN. The radar warning receiver is the biggest item in that amount?

General YATES. If I could clarify just a bit, sir? To produce the CORE ALQ-161, that work that basically revolves around it, it will take about $527 million. That is already in the baseline B-1B program. Those were expired year funds so it will be withdrawn and used, no new dollars that have not already been appropriated.

Then as Mr. Welch was just describing, for the radar warning receiver to be added on to the airplane, that would be about $489 million.

Mr. DORNAN. Is there a fall out with some of this development that can be put on fighters and pods for the F-16?

General YATES. The radar warning receiver comes from the fighters already developed, so there is nothing to do with the B-1. Well, I don't want to denigrate it. You must integrate it. That is always a sizable task, but it was developed in the fighter community.

Mr. DORNAN. To drop from $500 to $50 million, the Air Force must feel they are getting their money's worth out of the allocated funds in the 1989 fiscal year. Do they anticipate some good successes with applying this money to the B-1B?

Mr. WELCH. I think the $50 million that is in fiscal year 1990 that I spoke of, as I said, we were evaluating some options. That is simply about a 10 percent of the total program cost to complete the program, but we want to test it and know that it will work before we proceed in fiscal 1991 and subsequently.

Mr. DORNAN. For further clarification, because this is a new system, so we got up to only the second model number B, in World War II U.D. P-40 go up to N-O-P; P-38 went up to N-O-P. You would be spending some monies to upgrade the B-1B if this were a war-time situation. Some day you might have a B-1C or B-1D.

General YATES. Mrs. Byron mentioned monies we were spending to upgrade the F-16C. It is the normal way we have done airplanes forever. The threat changes. We have imposed different missions on the airplane. We learn things about the airplane. It is the normal evolution of an airplane.

Mr. DORNAN. Thank you. Let me ask you this: Of the 400 plus million needed to develop and employ a new RWR, how much is development and how much is procurement and retrofit?

General YATES. Roughly, round numbers, it is about $200 million in development. The other is in procurement and retrofit.

Mr. DORNAN. Right. Again using the World War II analogy, the threat until they reach the anti-aircraft site was the Luftwaffe fighters to our strategic bombers. Now it is blowing a path through the radars. Getting those radar warners to defend yourself is a new state of the art.

It is the difference between a penetrator that goes in and comes out or even gets to the target. I understand the great complexity here. I hope for a successful program. It was the distinguished chairman of this subcommittee that stuck the MONIKER B–1 in front of my name, Bob, and I wear it with pride.

It has been very pleasurable for almost 12 years now. I am sure the gentleman will appreciate my following the B–1B program very carefully.

Mr. DELLUMS. Did I do that?

Mr. DORNAN. Yes, you did.

Mr. DELLUMS. I am sorry about that.

Mr. DORNAN. It was 1977. It is getting to be ancient history.

I don't know if you gentlemen were on the House floor or watched a full television rendering of the President's State of the Union address. The largest applause at the President's speech for any remark from either side of the aisle was preceded by the President saying, "Don't get angry with me now, but we must stop micro-managing the defense budget."

The cost factors involved with the Small ICBM and the PK Rail Garrison, those are not small micro management items. I understand that. These are conceptual things with great support from leaders on both of the armed services committees, and we are dealing with such massive billions of dollars, I just want to here it again at this committee hearing.

If the Air Force, through its years of research, had its druthers with all the Strategic Air Command input and all your analysts from every Air Force electronic and strategic studies, think tank and the free world, you would go with just the Rail Garrison and spend those other dollars on other Air Force programs.

Mr. WELCH. In the past year the Rail Garrison was the cheaper of the alternatives that are mobile. That was what drove the decision last year to favor the Rail Garrison. Any time that you have an opportunity to complicate the life of a Soviet fighter by having multiple mobile systems, etcetera, you will always do that on a planning basis from the standpoint of all fundamental limitations aside.

It is very difficult to try to respond to the questions in a fenced environment but nonetheless things can be looked at in the abstract.

Rail Garrison was favored as a budgetary decision. The Air Force has no problem with the Small ICBM capabilities or the success of the program as well as the Peacekeeper Rail Garrison and its success.

General YATES. Straightforwardly, the answer to your question is given the budget constraints we had, the Air Force's decision was for the Peacekeeper Rail Garrison.

Mr. DORNAN. My final observation on that in response to one of Mr. Kyl's questions is a historical fact, a dynamic national democracy or republic with functioning legislatures never started a war in modern history—200 years.

Therefore, I do not see this Nation ever requiring or even tolerating the development of first strike weapons. Since all our weapons are to confuse the Soviet planners and buy time for, I used to say, peace—now I say, buy time for glasnost and perestroika to work

their way out. Then, of course, if dollars weren't to be considered a mix, would be fascinating. We would just assume complement streamline trains, using all our available rail lines around this country with trucks cruising around in the southwestern part of this country.

I still can't see them running any of the freeways in the other two-thirds to three-quarters of the country with the ice that I had to drive through this morning. But given the fenced amount of money we have to deal with, I just want it understood that we are forcing on the Air Force, although I wouldn't say it is micro management, a major decision—giving them a mix and eating up dollars that could go to, for example, a wild weasel going into the field with a new plan at 8 years because you both know fighter pilots with an interdiction mission love wild weasels tearing up SAM sites.

Other programs are going to suffer. I think that was the thrust of Mr. Kyl's question. If the Air Force is forced to develop a mixed subtracting adding $17 billion from zero sum pie here, then other programs are going to suffer.

We may never know what those programs are. That is why I would hope that we can expand what we learned in this subcommittee of this prestigious, major committee. Maybe we could have a briefing for all the Members in this room that shows when this decision comes down to mix Small ICBM and Peacekeeper Rail Garrison that the cost to other programs may be in the billions of dollars.

I would love to have an in-depth briefing. I know what the military's problem is. You come up here. You have the distinguished Senator of the other Armed Services Committee and the distinguished Chairman of this committee with a great deal of invested analysis and put in a lot of their good faith effort into the Small ICBM, it is like the Air Force is coming up to undercut them.

I don't know if you got an A team or B team where you could come up and have men in uniform pitch the Small ICBM. That would make Mr. Aspin feel good. I think because of the political overtones here, I don't think it is fair to not have the Air Force come up with their viewpoint and give to 40, 50, 60, hopefully 400 plus members the excellent briefing I got from Gen. Jack Chain at SAC headquarters last summer that convinced me.

I was on the fence on both. He convinced me, and that was the objective, I guess, that the way to go was the peacekeeper Rail Garrison. Would you be prepared to come up and give a briefing? Do you have men in uniform of any rank that would say we kind of agree with Mr. Nunn and Mr. Aspin?

Mr. WELCH. We have people that have gone through the analysis and looked at this. We can certainly share those results with people. Certainly the user who is, Jack, General Chain, is the person we must service with whatever we buy. I am sure that could be arranged if that is what you wish in terms of seeing his road map, if you will, the same as some of the road maps that we showed here today.

Mr. DORNAN. Mr. Chairman, so that we keep this bipartisan, I know Mr. Kyl and Mr. Welch and others all the way up to your

Ranking Minority Member on this committee would be anxious to do that.

I would like to make this bipartisan. Maybe others would say with closed doors here we could have a good briefing to show what the Air Force analysis was over many years they came up and said, "If we are given our druthers with the shortage of money, we would prefer to go with the Rail."

Mr. WELCH. From an operational community standpoint, Jack is a more proper person to be addressing these questions to.

Mr. DELLUMS. General Chain.

Mr. WELCH. Yes, and General Welch.

Mr. DELLUMS. General Chain will be here next week. Maybe we can work out an expansion to accommodate the gentleman. I think it lends to an expanded understanding. Hopefully, the debate will become more precise at that time.

Mr. DORNAN. Thank you.

Mr. DELLUMS. Is the gentleman from New York seeking recognition?

Mr. HOCHBRUEKNER. Yes. I would like to associate myself with many of the remarks Mr. Dornan made about the B–1B bomber.

From my point of view, I think certainly the defensive electronics are more complicated than the offensive electronics. Computers and radars and what have you are fairly old hat, notwithstanding new mechanizations. Certainly on the defensive side we recognize that as every new radar is developed by others, we must counter it.

Consequently the world of electronic countermeasures is a world that must be continually addressed. I think that is part of the reason why the ALQ–161 had its problems. Obviously it is a fairly old system in terms of the radar it was geared to address.

The B–1B should be a penetrating bomber and the defensive electronics should be upgraded. Obviously there is also time and room to converse about how to upgrade this. It needs to be upgraded because the B–1B should be a penetrating bomber.

I associate myself with many of the remarks Mr. Dornan made about the B–1B and the necessity to upgrade the defensive system.

Mr. WELCH. I think it would be remiss to say the B–1B is a not penetrating bomber today. I think what we are trying to do is make sure all of the capabilities, including the situational awareness and other things, that should be available to continue its capability, we want to continue to develop them.

Mr. DELLUMS. The gentleman yields back his time. The Chair would like to indicate at this point that Messrs. Dickinson and McCurdy requested that the Chair submit to the Secretary and the General a number of questions they would like responses to for the record.

[The questions may be found at the end of the hearing.]

Mr. DELLUMS. The Chair is going to indicate that the hour is drawing late, but there are more areas that the Chair would like to touch upon.

First I want to go back to the short-range attack missile tactical version, as I indicated earlier. Then I would come back with a question on the Boost Surveillance Tracking Satellite Program, followed by a question regarding close air support aircraft, and finally

to ask you, Mr. Secretary, to expound upon the National Aerospace Plane Technology Program.

First, go back to the short-range missile tactical version. I compliment all of my colleagues for staying, especially with accommodations to Mr. Kyl, who remained.

Before I put the question to you, Mr. Secretary, regarding SRAM-T, I would say I concur with my colleague from Arizona regarding the debate around INF. INF ostensibly was designed as well to eliminate a class of weapon. I think that we have a responsibility to think through whether or not certain programs bring back that class of weapon in a different version.

I am not just now talking about technical language, because here you ask a question and you get a technical response. That is the way of Washington. But we as policy makers have a responsibility if we are dedicated to the notion that the INF agreement eliminated a class of weapon, whether or not this is a reintroduction of that class of weapon in a different version.

Second, this is about modernization, and the obvious question is modernization of what weapon, whether it is a modernization of a weapon system that replaces a class of weapon system that was removed.

I agree, Mr. Secretary, the way the question was put before has to be answered at another pay grade, so I appreciate that. Let me ask you the question that I think is appropriate in this forum regarding SRAM-T. I would be interested in what you consider the requirements of this program, first question.

Mr. WELCH. General Yates is more involved with the program than I am. We will move back and forth if that is OK.

General YATES. The range requirement for the missile is classified. I can discuss that with you later. What we are trying to do here is as the defense around the targets increase, rather than send our airplanes and pilots into those targets to drop a gravity bomb on the target, what we want to do is stand outside and send a bomb in without the airplane. That is fundamentally what we are after.

Yes, also we are able to extend the range. If you take those airplanes with bombs to their maximum range, yes, you are able to attack targets beyond that because now the SRAM can be launched from the fighter.

Sir, I would like to say that I believe that it is not procedure and that it is a philosophical issue. Clearly, I understand the point that you are making. But, yes, the treaty was specific in what it addressed. We are talking about airplanes which were not addressed by the treaty and missiles on those airplanes which were not addressed by that treaty or any other.

I think what your point would be, if I could give you my view, you have a treaty in one specific area. What we hope is men of good will will be able to negotiate treaties in many interlocking areas. With a series of treaties, yes, you might be able to eliminate all weapons or most weapons in one area of the world. But to say this conflicts with the INF treaty is incorrect. This is not conflicting with the INF treaty at all.

Mr. DELLUMS. Let me put the question a different way. If it is an unfair question, I would like to know that. Let me put the question in perhaps more objective terms.

Are we replacing capability that we gave up in INF?

General YATES. Yes, because the target set has not gone away. What went away was the counterpart to our GLCM sites. Those go away, but the targets to be attacked don't change. They still remain the same. Whatever those targets are, if they were Soviet divisions or, rearming points or air fields or whatever those targets are, they have not changed.

Mr. DELLUMS. Your response is this does bring back the capability that was given up in INF?

General YATES. Not all of it. It does not bring back all the capability. You still don't have the range. In fact——

Mr. DELLUMS. The range is something we will talk about in executive session.

General YATES. We had *x* number of airplanes and we had to go with those *x* number of airplanes, *y* number of GLCMs. The GLCMs are being withdrawn. We have not changed *x* number of airplanes. The airplanes are still there. What we are changing is the method by which that same number of airplanes deliver their nuclear weapons.

By the way, there is one thing that goes back quite a bit. Just a second.

In 1983 there was an agreement with our NATO allies which we refer to as the Montebello, which involved reducing nuclear weapons in Europe and modernizing nuclear weapons. That is what this is all about. The issue is that the number of warheads is coming down, but those that remain have got to be more effective, in our view.

The analysis shows it is more effective. You have a higher probability of hitting the target without overflying in today's environment.

Mr. DELLUMS. I appreciate that response, and I wouldn't pursue that any further with you. I have a couple of follow-up questions regarding that. I am simply saying I think the issue of modernization is not a simple question. I think it is very complex, has enormous policy indications, and I think it is something we have to walk through with great diligence and great care.

As I understand it, this SRAM-T is very similar to the SRAM-2; is that not correct? Then my question is why do we need both? If they are so similar, why couldn't we just move with one, particularly against the back drop of the budget constraints that we are all dealing with?

If they are similar, why do we need to pursue SRAM-T and SRAM 2?

General YATES. We bought the SRAM-2s——

Mr. DELLUMS. Why do we need to develop two short-range tactical missiles?

General YATES. The SRAM-2s are bought to fill specific strategic needs. We have not bought extras, sir. We justified to the Congress, and with their support we bought just the number that we need. We now have a new requirement as we just discussed for the tactical forces, for the SRAM-T.

Even though we are able and it is saving us literally billions of dollars not inventing a new missile, we are using fundamentally the same missile. We still need additional weapons to go on tactical airplanes.

Mr. DELLUMS. Then what you are saying is that you have SRAM-II, but you have a need for SRAM-T to fill a new requirement. I assume the new requirement is a gap, as you perceive it as a direct result of the signing of the INF treaty?

General YATES. That is right.

[The following information was received for the record:]

As previously stated, the need for a tactical air-to-surface missile was identified prior to the INF treaty. It began in 1983 with NATO's Montebello Decision, which was designed to unilaterally reduce, and modernize, the number of nuclear warheads in Europe. SACEUR specifically outlined the requirements for this missile in 1985, prior to the INF treaty. There is an operational need for the missile; which is further validated as a result of the INF treaty. The SRAM-T will fill this need.

Mr. DELLUMS. Which takes me back to my early point that this does build in capability that was given up in INF. It seems to me one could intelligently argue that that then gives us a different way to come back with the same capability so the effects of INF are significantly reduced because you now have brought back the same capability. You started back at square 1, but now it is at a surface missile.

Would I be wrong in trying to logically think through that way?

General YATES. You are not wrong in what you say. Again, until people in the same spirit of peace who negotiated the INF are able to negotiate these interlocking treaties, the problems remain.

Mr. DELLUMS. I am just saying we generated a new system. We crated a new responsibility for another set of negotiations. Do we create on a geometric basis increasing problems for arms controllers because it is a never-ending process?

But that is a political discussion Mr. Kyl and I will have to debate on the floor. Let me go to the Defense Support Program, the Boost Surveillance Tracking Satellite Program.

If Phase I of SDI is in any way delayed, does the Air Force have a requirement to start the full-scale development of the BSTS early warning satellite system in fiscal year 1990?

Mr. WELCH. Yes.

Mr. DELLUMS. Can you explain, please?

Mr. WELCH. The BSTS system was looked at as a follow-on to the DSP to meet Air Force requirements independent from the coming into being of the requirements stated in the SDI Program. What you are seeing now is by adding to those requirements on the basic BSTS, one satellite can provide the opportunity to satisfy both sets of requirements.

BSTS was in being and was planned during this time period.

Mr. DELLUMS. Could we cut back on the DSP upgrade given your response?

Mr. WELCH. We are in the early phases of what we call demonstration and validation of the BSTS program to come. I think one wants to be very confident in terms of the performance before you do that. We are in the process of planning what is the proper phase-over from the DSP Program to a BSTS Program.

Also we had direction last year from the Congress to allocate some of the funds given to us to look at DSP evolved or DSP improved program, and we are proceeding to do that activity right now.

Mr. DELLUMS. Secretary, I will turn your attention now to close air support. Could you give your opinion as to where we ought to be going with respect to close air support? Have we made a good assessment of the survivability of the close air support aircraft given the lessons learned in Afghanistan?

Mr. WELCH. I will let General Yates answer.

General YATES. Yes, sir, we have. All of our analyses indicate that survivability is, one, a function of aircraft altitude; two, very heavily a function of speed; three, a function of the aircraft hardness. In other words, if in fact it is hit, what kind of damage is done by the hit, and, four, very much a function of avionics.

So the bulk of airplanes which people around town refer to as mudfighter are not players in such an arena because they don't have the sophisticated avionics that it takes to work in that environment.

We have done the analysis. I believe everybody in Washington that makes more than 40 cents an hour has got an opinion about this subject. I believe a lot of the confusion arises from the fact that they fail to realize that the aircraft are theater assets. These are assets to be used not just by a brigade commander, but in fact by an army commander and maybe cross armies.

The airplane has to be available where it is needed. It has to transit, so we see that there is more of a blending of close air support and what we call battlefield air interdiction, than there has been in the past.

Nevertheless, our analyses shows us that an A–16 is extremely survivable and extremely affordable and the most cost effective airplane that we see for the mission.

Mr. DELLUMS. Thank you.

My final question goes to the National AeroSpace Plane (NASP) Technology. I would appreciate it, General Yates, if you would give the committee and staff some update as to where that technology is at this point?

Mr. WELCH. We will switch back on you. Let me handle this.

I think that the NASP Program, is an excellent example of how people can work together to make significant accomplishments. It sets out many, many challenges. Whether it is in computational fluid mechanics, particularly propulsion, or other technologies, I think it represents an opportunity to build our technology base by the investment the Department of Defense and NASA are making.

Also the industry is investing their own money very heavily, to evolve technology and to develop a configuration that will move us into the hypersonic velocity arena. It is a program that has good support, as it should. But as you saw, it is also the biggest single item within our science and technology program. Therefore, it has continuous review and will be carefully reviewed through this process as well as through a DOD/NASA Steering Group.

There is not a time nor is it an appropriate way to accomplish things to build a whole series of facilities, etcetera. Another way to look at the National AeroSpace Plane is almost as a flying wind

tunnel. We measure in seconds or milliseconds the test time we actually have in ground test environments above Mach 8 to 12 or more.

So, we are moving forward and making progress on a day-by-day basis. We are trying to face up to determining the impact of the amended budget. We have activities going on right now. I have to tell you (NASP) is a well-managed program. I think it is addressing many of the most important technologies that we need for future AeroSpace Systems.

We will just have to see how well it can be supported through the budget decision process. We could give you a very long series of charts in each of the technical areas showing both the Government and the industrial participation. I think it would make people quite proud of what has been accomplished so far by industry working together with the Government activities. It is just a continuing challenge.

Mr. DELLUMS. Thank you for your answer.

Mr. Secretary, at this particular point I have a combination of public and private industry dollars working on the evolution of this particular technology?

Mr. WELCH. That is correct. In fact, there are almost as many industrial dollars as there are public dollars.

Mr. DELLUMS. Which leads me to my next question. At what point does it become a publicly financed program? At the advanced development stage?

Mr. WELCH. Again, I believe that we are——

Mr. DELLUMS. Right now it is a combination. At some point you and I know that it will become all Federal dollars. At what point is that in the process?

Mr. WELCH. Right now there are three teams on the vehicle and two teams on engine activity. We would hope that in the April/May time period this year we would have a criteria to select amongst these designs. Then, by a year or so from this time, we would get to Phase 3 (with proper funding) so that we could then commit to a flying airplane.

From that point on, that is, from the Phase 3 decision, it should be a Government funded program, recognizing that those people who are participating in the private sector would continue to make their normal capital investments in such things as facilities. I have to say this: NASP is a different type of technology investment, frankly, than one would see in the ATF as an example.

In ATF, one is going for a single shot kind of window. There was up-front knowledge of how much money from the public sector was available on a competitive basis. NASP prepares us for a future regime of operation, hypersonic velocity regime. I think it is in both our interests on the part of the Government as well as the Air Force to use the hypersonic regime to support mission areas.

But I think NASP also affects the future competitiveness of the air frame industry as well as the engine industry of the United States. I think it is a public marketability business decision, as well as a Government budget decision.

Mr. DELLUMS. Mr. Secretary, I am learning and have to amass some history in this regard. As I understand it, Phase 3 was to take place in fiscal year 1990. Is that now in jeopardy?

Mr. WELCH. In the present program that is funded in the budget and that we have before us to consider, it is not in jeopardy. With any budget cuts, we are looking into it, and we have several alternatives that we are looking at that would put a 1990 Phase 3 decision in jeopardy.

The budget we are specifically addressing, what you have before you, now was set to make that decision in 1990.

Mr. DELLUMS. In terms of relative priorities, do you perceive this as a very high priority item? It is a big ticket item in the budget. Is it a high priority item?

Mr. WELCH. In terms of reaching the far term technology objectives, it certainly would be high priority. As we try to balance the near, the mid-term and the far, I think that is the kind of thing we will have to trade off too. We would hope that as General Yates showed on the advanced launch system chart, the National Aero-Space System Plane might compete beyond the year 2000. As a single-stage-to-orbit vehicle it maybe one of the real ways to compete.

I have to say certainly in the long term, it is a very, very high priority. As we look to the mid and the near term and the balance of the dollars in this program, I think it has got to compete.

Mr. DELLUMS. Mr. Secretary General, given the hour, there are a number of additional questions that I would submit to you and ask that you respond for the record.

[The questions may be found at the end of the hearing.]

Mr. DELLUMS. Let me just personally say that I appreciate the presentation today. We all are trying to figure out a different way of making sense out of a very complex area that involves multi billions of dollars in literally hundreds and hundreds of programs.

So I appreciate your walking through for the committee from the science and technology phase to the system development phase because we need to walk these things through and try to understand to the maximum extent possible how these things evolve.

Over time we will have our political and economic and budgetary differences, but I know you folks are operating under some constraints because you don't know whether Mr. Reagan's final budget or Mr. Bush's new budget will be reconciled.

I appreciate the fact that you have participated in these hearings and responded to the extent that you have been able to respond. I realize at this point that you have to defend the program that you are laying out there and that we have to make some judgment about priorities as we perceive the ones the final budget comes in.

We will be working with each other over time because there are additional hearings, as we both alluded to, that will address major systems. We will have an opportunity to confront each other again on specific weapon systems.

Thank you very much for trying to make the kind of presentation that we agreed to in our informal hearings. On behalf of myself and members of the committee we thank you for your diligence.

The Chair will indicate that in Room 2337 at 10:00 a.m. tomorrow morning there will be an informal briefing on the Laser Program.

The subcommittee stands in adjournment until 10:00 a.m. tomorrow morning.

[Whereupon, at 4:35 p.m., the subcommittee was adjourned, subject to the call of the Chair.]

## F-16 DERIVATIVE PROGRAM (AGILE FALCON)

Mr. Dellums: The F-16 Agile Falcon represents, or appears to represent, a billion dollar development effort to upgrade the F-16. How much will the allies pay for this development?

Secretary Welch: The European Participating Governments (EPG), Belgium, Denmark, The Netherlands, and Norway, have signed a memorandum of understanding (MOU) for the predevelopment phase of the F-16 Derivative program, and they are paying 40 percent of the predevelopment costs. We are currently negotiating another MOU for the development phase of the program which will specify the EPG cost share for development. When the development phase negotiations are completed later this year, we will know how much the allies will pay for the development.

Mr. Dellums: What incremental improvements are we getting from this investment?

Secretary Welch: Planned enhancements include airframe and avionics upgrades. The airframe upgrades consist of a larger, 400 square foot wing which drives a 16 inch increase in fuselage length. With the larger wing, the F-16 regains the performance and maneuverability lost as a result of the weight growth of the F-16 over the years,

The large wing also improves payload capacity, loiter times, and range over earlier versions of the F-16 The avionics upgrades under consideration consist primarily of changing to a modular avionics concept which results in significant future growth capacity for adding advanced systems as they become available. Other avionics options being evaluated include systems to improve pilot-to-vehicle interface and situational awareness.

Mr. Dellums: Roughly, what will be the increased F-16 unit cost after the upgrade?

Secretary Welch: The unit cost is a function of the configuration of the aircraft. The purpose of the ongoing predevelopment phase is to determine the final, most cost effective configuration. Evaluation of configuration options, particularly with respect to avionics, is not yet complete. However, we currently expect the airframe upgrades (large wing) to increase the unit flyaway cost of a Block 50 F-16 by about $1.7 million in fiscal year 1989 dollars. The increased unit cost of a Block 50 F-16 for the avionics options under consideration range from $350 thousand to $1.8 million in fiscal year 1989 dollars.

## AMRAAM PRODUCT IMPROVEMENTS

Mr. Dellums: Secretary Welch, concerning the product improved version of the Advanced Medium Range Air-to-Air Missile (AMRAAM), what improvements are we getting with this program?

Secretary Welch: The current Air Force/Navy AMRAAM Weapon system provides a high performance missile that compensates for the numerically superior Warsaw Pact fighter/interceptor aircraft. The AMRAAM Pre-Planned Product Improvement (P3I) Program insures that the AMRAAM will keep pace with Warsaw Pact emerging threat developments in the areas of upgraded fighter/interceptor performance, ECM, and missile performance.

Specifically, AMRAAM P3I provides for:

1. Compatibility with the Advanced Tactical Fighter (ATF) through use of compressed carriage and data link upgrades.

2. Use of state-of-the-art Electrically Erasable Programmable Read-Only Memory (EEPROM) chips to provide field-level software reprogramming of the missile thereby reducing logistics costs and allowing greater flexibility in response to threat changes.

3. Upgraded Electronic Counter-Countermeasures capability to include hardware upgrades in the missile seeker and microprocessor to address threats that are not countered exclusively by software changes.

4. Improved fuze for use against low observable targets.

The FY90/91 funding will initiate the above AMRAAM P3I efforts that include studies and integration of technology programs into improved AMRAAM specifications.

Mr. Dellums: Will this program be opened to other contractors besides the current sources for AMRAAM?

Secretary Welch: From the beginning, the AMRAAM program has fostered competition and will continue to allow many qualified contractors to vie for the various components of AMRAAM. Competition is a key factor in reducing procurement costs. While currently maintaining competition at the prime/system integration level between Hughes and Raytheon, qualified contractors/vendors will be allowed to compete at various levels for product improvements of AMRAAM.

SLAM

Question: Secretary Welch, concerning the Standoff Land Attack Missile (SLAM), this Navy program is currently being evaluated as a possible standoff weapon for the B-52 in the Air Force version. How many systems are we now hanging on the B-52 in a tactical sense? I know we have the TACIT RAINBOW, HARPOON, and a number of other, possibly classified, systems. Is the SLAM system for the Air Force supported in the DOD Standoff Missile Master Plan?

Answer: The B-52 is capable of carrying a variety of weapons. In addition to research and development on the TACIT RAINBOW and operational capability of the HARPOON, a limited operational capability was attained in December, 1988 on the HAVE NAP conventional standoff missile. Tactically, a whole range of naval mines (500-2000 lb), gravity bombs (500-2000 lb), cluster bomb units (500-750 lb), and chemical bombs (750 lb) can be employed by the B-52. Deleted for security reasons.

A-7 UPGRADE

Mr. Dellums: Secretary Welch, concerning the A-7 aircraft upgrade program for the National Guard, what are the follow on production plans for this system?

According to your descriptive summaries there's a September 1989 production decision date, are there any funds in the budget for production?

Secretary Welch: The Air Force position has always been consistent on this issue; we want to fly the prototypes before we make a production decision. We intend to continue the prototype development and evaluation efforts and preserve the option to procure. The September 1989 production decision date was shown as a planning goal. The prototype contract is currently 8-10 weeks behind schedule; and, therefore, a more realistic production decision date will be no earlier than November 1989. There are currently no production funds in the budget. The results of the flight test evaluations of the YA-7F prototypes will contribute to a production decision along with validated cost estimates, force structure implications, and fiscal realities.

RAIL GARRISON

Mr. ~~Dellums~~ Dickinson: Please tell the subcommittee the status of both the Rail Garrison and Midgetman programs to this point in FY 89.

Mr. Welch: Rail Garrison remains on track. The program is in Full Scale Development, is within cost and on schedule. There are no major technical issues to be resolved. In fact, since Rail Garrison is primarily an integration effort, there is little risk in the program as long as it is adequately funded.

As a result of severe budget constraints the Small ICBM program was restructured in FY 88 based on a combined $700 million/$250 million FY 88/FY 89 program and $0 funding in FY 90 pending President Bush's Strategic Modernization Decision in April 1989. The FY 89 program continues to focus on flight test/integration efforts to support flight test missiles 1 and 2 launches in the 2nd and 3rd quarter of CY 89. All program efforts will terminate 30 September 1989 unless a favorable decision is given.

Mr. ~~Dellums~~ Dickinson: What is the impact of President Bush's recent decision to delay the obligation of any of the $350 million of FY 1989 ICBM funding that remains unobligated on both the Rail Garrison and Midgetman programs?

Mr. Welch: As you know, President Bush told you he would not spend any of the withheld $350 million of ICBM Modernization funds until 3 April. After 3 April, we will need to incrementally spend $60 million a month, of the $350 million, in Rail Garrison if that program is to maintain its scheduled IOC.

Mr. ~~Dellums~~ Dickinson: How much funding does the Midgetman program require during the remainder of FY 89 to remain viable? How are you defining viable?

Mr. Welch: To restore a viable missile plus hard mobile launcher basing program, the Midgetman program requires an additional $175 million. This additional funding would continue design activities and testing leading to a missile critical design review (CDR) in FY 91; start hardware and software design activities to support a HML CDR in FY 92; and lead to a CY 94 IOC. Approximately $100 million is necessary if contractors are to remain on board for a rapid restart in CY 90 leading to a CY 95 IOC.

## RAIL GARRISON CONCURRENCY

Mr. Dickinson ~~Dellums~~: This committee issued a report on ICBM Modernization a year ago. One of the primary concerns raised about the Rail Garrison program was its concurrency -- the overlap between development, testing, and production. In light of the recent 6-8 month slip in the program's IOC (from late 1991 to the second or third quarter of 1992), should we still be concerned about concurrency?

Mr. Welch: With the six month slip of IOC, there is even less concurrency than before and the risk presented to the program is minimal. As we indicated last year, there was very little risk associated with the concurrency in the Rail Garrison program because Rail Garrison is first and foremost an integration effort, that is, it takes an existing, tested missile and integrates it with existing railroad technology. As a result, concurrency is not a risk factor.

## MIDGETMAN

Mr. Dickinson ~~Dellums~~: What is the USAF's latest figure for the total cost of the baseline Midgetman program expressed in both FY 88 and then-year dollars?

Mr. Welch: The baseline SICBM program (500 missiles in the Hard Mobile Launchers) at the Minuteman Launch Facilities is $23.6 billion (FY 88) or $31.7 billion in then-year dollars.

Mr. Dickinson ~~Dellums~~: How much has this total program cost been reduced during the past six months? The past year?

Mr. Welch: The October 88 technical restructure reduced the cost by $3.9 billion (FY 88). The January 88 restructure reduced costs by $3.1 billion (FY 88), so the total reduction for the year is $7.0 billion (FY 88).

Mr. Dickinson ~~Dellums~~: How much of any such reductions is attributable to possible reconfigured programs (e.g., 2 warheads, larger missile, buying fewer than the baseline 500 missiles, etc.)? To increased management/development risk? To true reductions associated with technical successes, competition, smart management, etc.?

Mr. Welch: The following categories make up the majority of reductions for the above two actions.

COST REDUCTIONS

JANUARY 88 RESTRUCTURE
(Billions of Dollars)

| 3600 (RDT&E) | | 3020 (PRODUCTION) | |
|---|---|---|---|
| -1.3 | | -1.8 | |
| TECHNICAL BASE MANAGEMENT SYSTEM | (0.1) | REDUCED ENGINEERING CHANGE ORDER | (0.6) |
| ALTERNATIVE INERTIAL NAVIGATION SYSTEMS DECISION | (0.8) | REDUCED CEILING | (0.4) |
| GENERAL SUPPORT | (0.2) | ASSEMBLY AND CHECKOUT SPARES, PUBS | (0.3) |
| DUAL PROPULSION SOURCE | (0.2) | PASSIVE ACCESS DENIAL SYSTEM | (0.1) |
| | | GENERAL SUPPORT | (0.1) |
| | | REENTRY VEHICLE LINE OPEN | (0.1) |
| | | POST BOOST VEHICLE | (0.2) |

OCTOBER 88 RESTRUCTURE
(Billions of Dollars)

| | | | |
|---|---|---|---|
| -2.3 | | -1.6 | |
| REDUCED FLIGHT TESTS | (0.3) | REDUCED AGING AND SURVEILLANCE HARDWARE | (0.1) |
| USE DT&E INSTRUMENTED RANGE SAFETY SYSTEM | (0.2) | INSTRUMENTED RANGE SAFETY SYSTEM SUBSETS | (0.1) |
| LESS TEST UNITS | (0.1) | LOGISTICS SUPPORT EQUIPMENT | (0.4) |
| LESS GROUND TEST MISSILES | (0.1) | REDUCED ENGINEERING CHANGE ORDERS | (0.5) |
| REVISED ESTIMATES | (0.3) | GUIDANCE AND CONTROL TOOLING | (0.1) |
| REDUCED ENGINEERING CHANGE ORDER | (1.0) | REDUCED CEILING | (0.4) |
| GENERAL SUPPORT | (0.2) | | |
| SECOND SOURCE | (0.1) | | |

MIDGETMAN RAMP-UP

D. Dellums

Mr. Dellums: Recently there has been talk of developing a consensus on ICBM Modernization that includes both Rail Garrison and Midgetman. However, Midgetman has not been fully funded since FY 87 and has been greatly down-scoped during the past two years. If a two missile consensus does emerge in the coming months, what level of funding is required to "Ramp-Up" the Midgetman program?

Mr. Welch: The level of funding depends on what the new administration decides to do. Until the completion of the President's Strategic Review, we will not be able to predict the outcome.

Mr. ~~Dellums~~ Dickinson: From a purely fiscal perspective, can we afford to develop and deploy both programs in view of the likelihood of flat defense budgets in the years ahead? What would the annual costs of this two missile program be (approximately) over the FY 90-94 FYDP? How might each program's schedule be impacted by a two missile program?

Mr. Welch: The country can afford a two mobile missile program if that is the commitment of the administration. In a restricted Air Force budget, we decided to pursue Rail Garrison as the quickest, least costly alternative in the FYDP period. A two missile program would be best served by deploying Rail Garrison and later, consistent with requirements, deploy Small ICBM in the mid to late 1990's.

Mr. ~~Dellums~~ Dickinson: If both programs do proceed and you take into account the different scope and schedules of each, is it more cost-effective to finish developing and then deploy Rail Garrison before Midgetman? Or vice versa?

Mr. Welch: If both programs proceed, it is imperative to do Rail Garrison first in the sequence. Without Rail Garrison first, there is no credible arms control lever to move the strategic negotiations forward. Proceeding with Rail Garrison first also allows a cost savings of approximately $1.2 billion and avoids a costly dual production program in the late 90's.

CARRY-HARD

Mr. Dellums: We have heard a lot about the Carry-Hard concept during the past several months. In light of the system's high cost, conceptual similarity to the old multiple protective shelter (MPS) proposal, and technical uncertainties, I believe Carry-Hard is little more than a thinly disguised effort to delay Rail Garrison while we continue to "study" MX basing modes. What is the USAF's view of Carry-Hard? Has the USAF done its own analysis of Carry-Hard and, if so, would it be opposed to providing any such analysis to the Committee?

Mr. Welch: The Air Force has considered Carry-Hard as a potential basing mode in the past. It was one of the four final basing modes considered in the December, 1986, decision on a basing mode for Peacekeeper. It was not chosen because it was more expensive than Rail Garrison, it depended on concealment that was fragile and uncertain and it was projected to have severe public interface problems. In addition, multiple protective shelter schemes had been previously rejected during both President Reagan's and President Carter's terms.

The Air Force is not considering Carry-Hard as a basing mode. It would be presumptuous to suppose the motives for a renewed consideration of Carry-Hard at this time, but it would have the effect of delaying the deployment of Rail Garrison and Small ICBM.

We would be pleased to have some of our technical experts provide a briefing on Carry-Hard at your convenience.

Midgetman Options

Question: Does the USAF believe that a 2-warhead Midgetman, at either 37,000 or 45,000 pounds is a viable option? Why or why not? Can you please provide the committee with a detailed break-out of the various Midgetman options under consideration, including the advantages, disadvantages, schedule and cost implications of each.

-- Specifically, what happens to the Midgetman's planned penaids capability with a 37,000 pound, 2-warhead missile? If it is diminished, how does that impact the strategic viability of the Midgetman over the life of the program?

-- What happens to the random, Southwest basing option for Midgetman if you deploy 2-warheads on a 37,000 pound Midgetman? On a larger, 45,000 pound Midgetman? How much importance does the USAF attach to the random, southwest basing option if the Midgetman program does not proceed?

Answer: The AF believes the single-warhead, 37,000 lb Small ICBM baseline program provides earlier operational capability and better flexibility to meet military requirements and entertain growth options to respond to future mission demands.

The 2-warhead 37,000 lb variant, for the same number of total warheads, limits operational flexibility by decreasing range, target coverage, basing options and survivability. MIRVing, along with adding additional weight: 1) degrades target coverage at Minuteman basing; effectively precludes target coverage from southwest basing without downloading to one warhead 2) precludes employing Minuteman-type penetration aids without downloading, 3) reduces targeting efficiency and 4) decreases system survivability (i.e., cutting the number of missiles deployed by half reduces area generation during the first several minutes of dispersal due to the fewer number of starting points). Moreover, if fewer missiles were deployed at less than the three Minuteman bases in the baseline program, total area generated would be reduced as well, thereby reducing Soviet attack price. This option could be deployed in the same time frame as the baseline at reduced cost due to decreased missile procurement.

Stopping development of the 37,000 lb Small ICBM in favor of a 45,000 lb 2-warhead alternative would add back flexibility by increasing range and payload capacity but would suffer mobility drawbacks (due to size and weight) greater than the 2-warhead 37,000 lb version. Additionally, it requires complete redesign due to the larger missile diameter, adds approximately four years to baseline initial operating capability and adds to sunk research and development costs.

If the Midgetman program does not proceed, the USAF has no further interest in the random, Southwest basing option.

NASP OVERSEAS EFFORTS

Question: The NASP program has great technological potential in terms of both commercial and military applications.

It is my understanding that our European allies as well as the Japanese and the Soviets have very active programs in hypersonic research.

(A) Can you describe for the Committee the nature of these overseas efforts and where the U. S. stands vis-a-vis the Europeans, the Japanese, and the Soviets?

(B) What do you believe to be the technological consequences should the U. S. relinquish the lead in this area?

Answer: (A) Overseas efforts include the following:

France: The French are working on a recoverable orbiting spaceplane called Hermes which will be launched by the Ariane 5 expendable launch vehicle. At this time they do not seem to have significant project activity on a true aerospace plane.

Federal Republic of Germany: The West Germans have a project for Sanger, a two-stage-to-orbit vehicle, that uses an airbreathing first stage. The first stage, probably powered by an air turboramjet, would accelerate to Mach 6-7 from which point a rocket-powered second stage would travel to orbit. This project, which is partly funded by the German government, could lead to a development program culminating with a first flight in the first or second decade of the twenty-first century.

United Kingdom: The British program HOTOL (for Horizontal Takeoff and Landing) is aimed at achieving single-stage-to-orbit with a vehicle that is powered by an airbreathing rocket which transitions to a pure pocket above Mach 5. HOTOL was funded by the British government until the end of 1987 and has been carried on since then on company funds (from British Aerospace and Rolls Royce). The development period for HOTOL from start of significant funding to flight test is projected to be approximately 10 to 12 years.

Japan: Japan has active programs for current space vehicles including the H-II launch vehicle and the H-II Orbiting Plane (HOPE). HOPE is a winged, recoverable, orbiting upper stage. HOPE is neither airbreathing nor single-stage. There is active research on a single-stage-to-orbit aerospace plane as well as hypersonic transport aircraft in Japan. At the moment the level of effort on a hypersonic transport exceeds that on a true aerospace plane.

Dr. Robert Barthelemy, the Director of the NASP Joint Program Office made a trip to the above four countries (France, Germany, U. K., and Japan) in the fall of 1988. The following table provides his assessment of the status of these efforts:

| Country | Concept | Effort | Level of Effort | Basic Capability | Status vs U.S. |
|---|---|---|---|---|---|
| U. K. | HOTOL-Space Plane | Private Venture | Low | Medium | - 5yrs |
| France | Hermes | Multi-National | High | N/A* | N/A* |
| Germany | Sanger-Aerospace Plane | National Program | Medium | Medium/High | - 3yrs |
| Japan | Hypersonic Transport | National Program | High | Medium/High | Par |

| Country | Concept | Effort | Level of Effort | Basic Capability | Status vs U.S. |
|---|---|---|---|---|---|
| Japan | Aerospace Plane | National Program | Medium | Medium | - 3yrs |

* Not applicable (Hermes is not an aerospace plane)

Soviet Union: The Soviet Union has demonstrated strong capabilities in the development of technologies in the areas of advanced materials, propulsion, mathematical modeling, and computers - areas fundamental to the development of an aerospace plane or hypersonic vehicle. It is believed that the U. S. has a lead in the propulsion and materials technologies; however, this lead is, at most, by only a few years and could erode rapidly should the Soviets make a determined effort. The Soviet Union has long demonstrated a keen interest in hypersonic flight and has invested heavily in facilities for hypersonic research.

It is anticipated that a project similar to NASP could be undertaken by the Soviets based on recognition of the obvious benefits and capabilities that such a vehicle offers in terms of access to space and reduced cost per mission.

The General Accounting Office has recently completed a study of investment in foreign aerospace vehicle research and development efforts, and have an excellent briefing available on their results (with the concurrence of the House Committee on Science, Space and Technology which requested the study). The point of contact is Mark A. Pross, Evaluator-in-charge, GAO/NSIAD/Air Force, Tel: (202) 275-8094.

(B) Consequences of U. S. relinquishing its lead:

The goal of demonstrating and testing NASP provides a focus for numerous technology development efforts that will afford considerable technological benefits to the U. S. aerospace industry, since many of the advances being pursued by NASP are applicable to other aerospace systems. The aerospace business sector is one of the few remaining in which there is a balance of trade favorable to the U. S. It is widely believed by leaders in the aerospace industry that our ability to maintain this advantage is linked to the NASP program and to the aggressive pursuit of NASP technologies. The NASP program should allow the U. S. to keep a step ahead of our international competitors in the world marketplace. From the point of view of military consequences of another nation gaining a lead in NASP technology, the operational advantages of NASP-derived vehicles (unrefueled, global access in less than 2 hours, etc.), if employed by our opponents, could represent a significant threat to national security.

## NASP R&D EFFORTS

Question: One area where the U. S. trade balance remains strong is in the field of aerospace. It is my understanding that only in aerospace and agriculture do we enjoy a positive balance of trade.

(A) With this in mind, can you comment on the role NASP is playing in focusing aerospace technology R&D efforts.

Answer: The goal of single-stage-to-orbit with an airbreathing, reusable, aircraft-like vehicle is providing focus for the development of specific technologies that will enable fabrication and test of such a vehicle. Generic technology development projects, without the focus of a tangible, measurable goal like NASP, cannot be expected to make the kind of progress seen in the NASP technology maturation program. The allocation of resources to NASP technology challenges is resulting in rates of progress several times faster than in a "business-as-usual" technology development program.

NASP technologies will ensure flexible, affordable space access for both civilian and military applications, and will offer additional direct payback to numerous other aerospace programs. The technologies being pursued by NASP (materials, propulsion, structures, computerized fluid dynamics, etc.) have direct applicability to many other aerospace products and will help assure the U. S. maintains a position of world leadership in this field.

## NASP CAPITAL

Question: The DOD request for NASP is $299.7 million. Clearly this is a considerable sum of money in a tight budget year. Will you comment on industry's involvement in this program and the amount of private capital being spent?

Answer: Industry is a full partner in the joint DOD/NASA National Aero-Space Plane (NASP) program. Not only has industry put some of its best and brightest people to work on NASP, it is also investing large amounts of private capital in the program. In fact, NASP is a unique cooperative government and industry venture. Voluntary industry investment through 1990 will exceed $750 million. In FY 90, alone, industry plans to invest in excess of $166 million in the NASP program. In addition, the program is a prototype for industry cooperation where the companies involved are sharing their proprietary data in areas such as materials development to resolve technical challenges. This novel approach will help improve our competitiveness in the international market. Moreover, the strength of the industry commitment permeates the technical community. Over 5,000 people in companies and universities across America are enthusiastically involved in NASP research.

## NASP - DSB

Question: It has recently been reported that the DSB considered the NASP program schedule overly optimistic in light of the need for technology maturation.

(A) Do you feel that the NASP schedule is manageable in terms of technological milestones?

(B) What steps have been taken to address the concerns raised by the DSB?

Answer: (A) Yes. Although the schedule is highly challenging we believe it is attainable. This conviction is based on the veritable milestones achieved up to date and the fact that no insurmountable technical obstacles to X-30 development have been identified to date.

(B) Since the DSB assessment, (which was based on NASP status prior to June, 1987), the NASP program has incorporated many of the DSB recommendations. During the past twenty months both program content as well as overall schedule have been modified to address the DSB concerns. Specific examples include: formation of the materials consortium and application of a budget of over $158M to focus and accelerate materials for NASP; similarly, additional consortia are being established for key subsystems; and lastly, first flight of the X-30 has been scheduled for fiscal year 1995, giving the program an additional year to mature the required technologies to the point where an intelligent decision can be made on our readiness to go forward with the design, fabrication and flight of two X-30 flight research aerospacecraft.

WHY NASP

Question: This Committee and this Congress must make many difficult budget decisions regarding national priorities. Many worthwhile programs will need to be cut and some terminated.

(A) Can you, in simple terms, tell the Committee: Why NASP, and why NASP now?

Answer: The compelling motivation for pursuing the National Aero-Space Plane (NASP) program is the high payoff expected from NASP-derived operational vehicles. Operational vehicles derived from what we learn with the X-30 will combine the attributes of aircraft and conventional space launch vehicles to provide a new generation of reliable, flexibly-based, aerospace vehicles with unprecedented capabilities, foremost of which is low-cost, rapid response, manned access to low earth orbit.

We must pursue NASP aggressively now because of the long lead time required to obtain this operational capability. Even with a very aggressive schedule the earliest we could deploy operational vehicles based on NASP is early in the first decade of the twenty-first century. As only one example of the need for NASP, we note that by the year 2000 Shuttle technology will be thirty years old and the Shuttle fleet will be near the end of operational life. If the nation wishes to exploit the high payoff potential of NASP in a follow on to the Shuttle, we need to continue moving ahead with the orderly, phased technology demonstration program we started three years ago.

A further, important, reason to pursue NASP aggressively now is based on the threat to our leadership in the world aerospace market place (military and civil). The technologies being developed for NASP are vital to maintaining our lead. This fact has been recognized by the industry participants in the NASP program and is one of the important factors stimulating their large corporate investments and their strong support to the program.

# DEPARTMENT OF ARMY RDT&E BUDGET FOR 1990

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Thursday, March 9, 1989.*

The subcommittee met pursuant to call at 10 a.m. in room 2337, Rayburn House Office Building, Hon. Ronald V. Dellums (chairman of the subcommittee) presiding.

## STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The subcommittee has taken testimony from the Departments of Navy and Air Force on their long-range planning for research and development and the systems which will not be covered in separate hearings. Today we will take testimony from the Department of Army on their long-range planning and systems.

The Department of Army has the smallest research and development budget compared to the other two services. In spite of the magnitude of their budget, there are several very important issues which the subcommittee needs to review with the witnesses today. Two of these subjects which I am sure the membership will have very high interest in are the modernization of tactical nuclear weapons, specifically LANCE, and the ARMOR/ANTI-ARMOR Programs, such as the modernization of the Army's main battle tank.

During its previous hearings the subcommittee has repeatedly come up against the situation of having before it the Reagan fiscal years 1990–1991 budget requests. The witnesses have testified to that budget request here in Congress, while back in the Pentagon they are reassessing budget priorities with respect to the budget which will obviously be of most help to us since we are planning to mark the budget early in April. We do not know how much time we will have to study the details of the Bush budget request.

I have noted in reviewing the gross numbers for the Department of Army's R&D request, that during the 4-year period for fiscal year 1988–1991, the Department of Army's research and development programs have continuously increased. This is a unique situation compared to the other two services which have both taken reductions in the 1991 R&D budget requests.

I hope that you will be able to discuss the situations and programs that have resulted in your service having this unique situation, especially with respect to those programs that range from research through advanced development.

The witnesses, Dr. Jay Sculley, Assistant Secretary of the Army for Research, Development and Acquisition; Lt. Gen. Donald Pihl, Military Deputy to the Assistant Secretary of the Army for Research, Development and Acquisition; and, Mr. George Singley, Director for Army Research and Technology.

Since Mr. Dickinson is not here, does my colleague, Mr. Kyl, wish to make an opening statement?

Mr. KYL. Thank you very much. I don't have a statement, but I would also like to welcome the witnesses.

Without objection, your statements will appear in the record.

**STATEMENT OF DR. J. R. SCULLEY, ASSISTANT SECRETARY OF THE ARMY FOR RESEARCH, DEVELOPMENT AND ACQUISITION**

Dr. SCULLEY. Thank you, Mr. Chairman.

I appreciate your putting in the record our prepared written statement, as well as our volume on "Equipping The U.S. Army."

I would appreciate very much to have a minute or two to give you some very brief comments on the progress and accomplishments of the United States Army over the last 8 or so years. Today, the Army is benefiting greatly from the dramatic improvement in the 1980's of the quality of the young soldiers.

Education levels are up significantly. While back in 1980 only 54 percent of those entering the Army had high school diplomas, we have exceeded 80 percent every year since 1981 and this year we project that 93 percent of our recruits will be high school graduates.

Further, our testing results place 66 percent of last year's recruits in mental categories I through IIIA. In 1980 only 26 percent were in that category. In 1980 we had 57 percent in mental category IV. This past year we had only 4 percent. The positive impacts of these fine young soldiers can be seen in the dramatic reduction in disciplinary indicators.

As an example, the drug use rate per thousand soldiers is down from 38 incidences per thousand soldiers in 1980 to only 8 in 1987. AWOL is down from 89 per 1,000 to only 12 per 1,000 in that same year. There has been a 50 percent reduction in both property crimes and violent crimes over the same period. Their performance with our new equipment, I think, is typified by our winning the world helicopter championships and our M-1 crews winning the prestigious Canadian cup for the first time in history.

Let me turn to the equipment side of the house for a moment. In 1981 the Army was pursuing research and development on modernized systems following the Vietnam era. Very little procurement of modernized systems had occurred and programmed funding for these acquisitions was clearly inadequate.

Under the leadership of the President, and with the backing and support of the Congress, which we appreciate, funding for procurement of modernized systems was substantially increased and there followed the largest peacetime modernization program in our history, a process which continues.

Remembering back to 1980, the Army had only 100 modernized helicopters; all of them UH-60 Black Hawks. There were no Apaches, no AHIP's and no CH-47D's. Today we have procured

over 1700 modern helicopters and plan to add at an affordable rate 200 more each year.

In our armored forces the pace of modernization has been even more dramatic. Fielding of the basic M-1 Abrams tank was completed in 1986. Since then we have fielded over 1500 M-1A-1 Abrams tanks with the 120MM gun and other substantial improvements.

To date funding has been provided for over 7000 Abrams tanks and we are now proceeding with the Block II improvement program to insure we continue to provide the finest soldiers in the world with the finest tank in the world.

Without question the most significant advancement in the crucial area of fire support has been the development and fielding of the Multiple Launch Rocket System. By the end of this fiscal year we will have fielded 27 tactical batteries of MLRS and placed another six batteries in POMCUS.

Ultimately with the fielding of the ATACMS, which is currently in development, this system will provide our field commanders with the means to prosecute the attack portion of the deep battle. While I am on the subject of systems which will change our future, I feel I must make mention of what perhaps is the most successful weapon ever fielded by the United States Army, that being the Pershing II with its dramatically enhanced accuracy and range.

I feel it was largely responsible for bringing the Soviet Union to the negotiating table in what resulted in the Intermediate Nuclear Forces treaty to completely eliminate this class of weapon.

While substantial progress has been made, it is imperative that we maintain the momentum of our modernization process.

Fiscal year 1990 marks the fifth consecutive year without real growth in the total Army budget. As we look to the future we are all aware that we will be in an austere funding environment. This makes stability in funding essential to effective management.

In closing, let me say that in the coming years we will need support from the Congress to insure the stability of our resources. Of equal, if not greater, importance is the fact that we must have a vision of the future to provide a focus for our research and development efforts to insure that we remain competitive.

With me today I have really the preeminent career people both civilian, in Mr. Singley and my Military Deputy, Lt. Gen. Don Pihl. With your permission I would turn it over to Don Pihl for his corporate overview on a force modernization strategy followed by Mr. Singley talking about our technical base master plan.

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PREPARED STATEMENT OF DR. J.R. SCULLEY

**STATEMENT**

Mr. Chairman, members of the committee; it is a privilege for me to appear before you to present the Fiscal Year 1990 budget request for the Army's Research, Development, Test and Evaluation Program.

Our budget request for Fiscal Year 1990 is for $5.6 billion. This request represents our best effort to focus on research and development projects that promise the greatest potential for improving our warfighting capability and maintaining our scientific and technological competitiveness. We are all aware that the budget was submitted by the outgoing administration. The Department of Defense is revising the FY 1990 and 1991 Biennial Budget based on new guidelines.

The Army has made steady progress in its equipment posture in the 1980's, and our overriding concern is to maintain that progress as we look forward to the challenges of the 1990's. The need to keep our conventional forces strong has been further amplified by the recent signing of the Intermediate Nuclear Forces (INF) Treaty. Although the INF Treaty is a welcomed action, it poses an additional challenge to the Army to enhance its conventional capabilities and strengthen our position as a globally deployed, strategic force for deterence.

The qualitative leverage we possess in some equipment

areas must offset Warsaw Pact quantitative superiority and unrelenting Soviet technological advances. Our RDA investment efforts of the 1980's have resulted in an Army better equipped to combat the threat across the entire spectrum of conflict; however, the Soviets have also been making steady improvements.

For years, the West has relied upon its technological prowess to meet the military threat posed by numerically superior forces of the Warsaw Pact. Since the late 1970s however, the Warsaw Pact's quantitative advantage has been complemented by qualitative force enhancements.

Research and development by the Soviets is paying off with technological advances which rival, and in some areas may surpass our own. This is particularly true for ground force weapons systems where research and development accounts for a significantly greater share of defense resources in the Soviet Union than it does in the United States.

While the current direction of internal Soviet political debate over the allocation of defense resources is likely to result in lower military procurement levels in the next 2-5 years, perhaps sooner, there is no historical precedent nor evidence to suggest defense R&D in the USSR will suffer. Soviet use of space-based systems to enhance their ground combat capabilities will also provide them better warning, command and control, and synchronization of ground force actions.

Difficult as the Soviet challenge to the U.S. may be, the Army cannot concentrate exclusively on the Soviet threat. Every reasonable forecast envisions continued instability and conflict in the Third World. Opposition forces will have at least a few weapons systems comparable to or better than our own. In some cases, they already possess a full range of modern, sophisticated weapons which are available from the world arms markets or from sponsors such as the Soviet Union.

The Chemical/Biological Warfare threat is not only worldwide, but it is growing and changing in character. The Soviet Union continues to take advantage of emerging technologies in the fields of biotechnology and genetic engineering to develop new agents. These new agents result in the potential for technological surprise that poses unique challenges to our defensive capabilities. As with the conventional threat, we cannot focus just on the Soviet capability. The proliferation of chemical capability throughout the world has grown at an alarming rate. Third World countries view chemicals as a cheap and effective weapon, as was seen in the Iran/Iraq War. I am sure you have read of other international developments in this arena which give great cause for concern. Today, forces deployed to meet Third World contingencies face great risk.

The Army must continue to vigorously pursue R&D efforts in order to meet the entire spectrum of future threats. Today's

rate of technological change is increasing exponentially. As a result, we cannot neglect the future of R&D -- as we did during the Vietnam era, and expect to regain our superiority.

To address this reality in a fiscally and operationally disciplined manner, the Army has developed a framework for our future modernization that includes comprehensive, resource constrained plans in a variety of functional areas. The Army Aviation Modernization Plan (AAMP) presented to Congress last year was the first. Soon to follow are Armor/Anti-Armor (A3), Heavy Force, Fire Support, Air Defense, Truck, Command and Control Modernization Plans and the first Army Technology Base Master Plan..

I would particularly like to emphasize the importance of the Army Technology Base Master Plan, which will provide the technological underpinning for our modernization. This plan, and the investment strategy documented therein, focus and harness our technology base. This plan is due for release next month, and it is my desire and intention to share it with this committee at the earliest possible date. We also intend to provide the plan to Department of Defense contractors to better focus and leverage Independent Research and Development.

As we look to the future, we can be sure of one thing; we will see technology continue to radically change the nature of the battlefield in the same way it has done in the recent past.

It has, for example, improved firepower and mobility, target acquisition, battlefield survivability and medical care. Improvements in such technologies as electronics and night vision have greatly increased the individual soldier's sphere of battlefield influence. Other by-products of this technological change include increased information flow during continuous operations over an extended, integrated, highly lethal battlefield.

The Army's Airland Battle Doctrine is an effort to translate the meaning of such continuing technological change into winning battlefield strategy. The Army considers the technology base an indispensable "Corporate Investment" to ensure continued technological superiority of our forces. While private businesses may get a second chance to make up for inadequate "Corporate Investment," we have only to look to history to read numerous accounts of battles lost and armies defeated because they failed to accommodate technological change soon enough.

Often, decisive technological changes have come from unexpected areas, and the well worn phrase "avoiding technological surprise" is inherent in our efforts to sustain our world class research, focus on the critical breakthrough technologies and exploiting focused technology demonstrations to speed the transition of technology out of the labs and into full scale development.

The Army's technology base program is, thus, dedicated to identifying, maturing and transitioning technologies to achieve our vision of a future Army, second to none. The Basic Research (6.1) program exploits science, identifies technological opportunites and maintains a vital link with university and industry research. Our exploratory development (6.2) program evaluates the technical feasibility of advanced concepts. Finally, non-system specific advanced development (6.3A) efforts speed the transition of technology by conducting demonstrations of advanced technology components, subsystems and systems so that we evaluate technical risk and operational promise prior to full scale development.

This year, the Army has taken important initiatives to focus and strengthen the technology base to increase its quality and contribution to future warfighting capability. Our Technology Base Investment Strategy is documented in the Army Technology Base Master Plan which provides top-down guidance and focus to Army Research and Development activities. Major elements of this strategy include:

-- Meet near-, mid-, and far-term warfighting needs,

-- Reduce the lead-time for introducing new technology into our weapons systems,

-- Retain our leadership in high technology,

-- Identify and exploit key emerging technologies,

-- Leverage other Service, other Government agency, industry, academia, and international investment, and

-- Balance resources among future systems, supporting capabilities, systemic problems, key emerging technologies and basic research.

Success in this overall strategy will ensure we make the right choices and set the right priorities in our research, development, test and evaluation program.

I have with me today my Military Deputy, LTG Don Pihl and my Director of Research and Technology, Mr. George Singley. They will talk to these programs in much greater detail at the conclusion of my remarks.

In closing let me say that our Fiscal Year 1990 budget request represents a balanced program to equip the Army. Our broad-based modernization program, the greatest in peacetime history, is allowing us to provide our soldiers with the quality equipment they need to maintain deterrence and prevail in case of war.

We must continue to buy and allocate our new equipment with sound business sense and solid military rationle. Our major concern is that further reductions and declining economic resources will erode our ability to achieve that goal. It is a business axiom that it is futile to try to merely catch up to a

competitor -- you must leap ahead. Our present major procurement programs have achieved a quantum jump in performance capability. As our Army prepares to move into the next decade, our RDA goal is to continue that trend. The main determinant in our ability to succeed in the 1990's is a sound investment strategy supported by adequate and stable funding. Accordingly, we need the continuing strong support of Congress.

I thank you for the opportunity to testify before you today.

**STATEMENT OF LT. GEN. DONALD S. PIHL, MILITARY DEPUTY TO THE ASSISTANT SECRETARY OF THE ARMY (RESEARCH, DEVELOPMENT AND ACQUISITION—DEPARTMENT OF THE ARMY**

General PIHL. Thank you, Mr. Chairman.

It is a privilege for me to appear before this committee. Our request is for $5,603,000,000 in R&D. The technology base portion of that is $1,238,000,000. I will focus on the systems developments in my briefing and Mr. Singley will focus on the technology base. You have briefing charts from each of us. We will not brief every chart, but we will summarize the bulk of the charts.

# ARMY

# FORCE MODERNIZATION STRATEGY

## A CORPORATE OVERVIEW

## BY LTG DON PIHL

G125Z.12

## THE ARMY - A STRATEGIC FORCE

- ✓ CENTERPIECE OF CONVENTIONAL DEFENSE
  - ➨ DETER WITH THE MAN ON THE GROUND FORWARD
  - ➨ RAPID DEPLOYMENT TO CRISES AREAS
  - ➨ DETER -- RESPOND -- REINFORCE -- FIGHT -- WIN
  - ➨ BUILT ON 5 CORPS:
    - ➨ 18 ACTIVE DIVISIONS
    - ➨ 10 NATIONAL GUARD DIVISIONS
    - ➨ ARMY RESERVE UNITS
- ✓ STRATEGIC ROLES, MISSIONS
  - ➨ EVER PRESENT...INCREASING
  - ➨ CURRENT CAPABILITIES ARE MINIMUM ESSENTIAL

G125Z.12

If I could refer to my briefing, the strategic force chart, we understand our mission to be deterrence. We think that our missions of deterrence, responding, reinforcing, fighting and winning are built on our five corps with 18 active divisions, 10 National Guard divisions and Army Reserve units.

We provide the regional CINCs (Commander in Chiefs) heavy, light and special operations equipment

G125Z.17

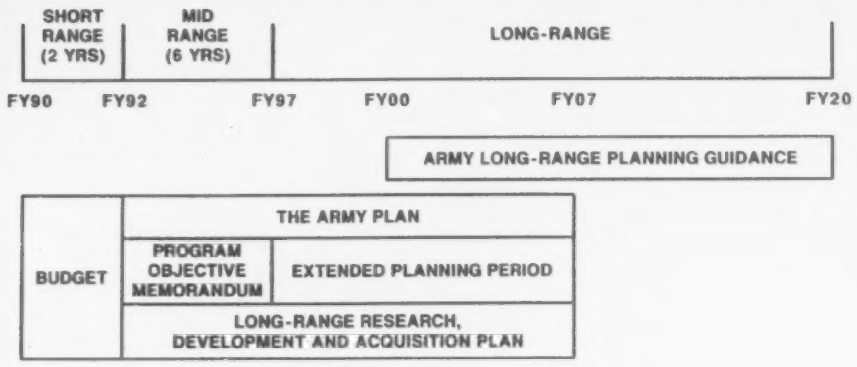
## ARMY LONG-RANGE PLANNING GUIDANCE

- ✓ LEADERSHIP'S VISION INTO THE 21ST CENTURY
- ✓ GUIDES DECISIONS TODAY - SHAPES TOMORROW'S ARMY
  - ➨ ONE GENERATION AHEAD
- ✓ BRING LONG-RANGE CONSIDERATIONS TO BEAR ON PLANNING, PROGRAMMING & BUDGETING PROCESS
- ✓ STIMULATE DEBATE ON HOW TO ACHIEVE LONG-TERM GOALS

G125Z.17

On chart 3 is the Army long-range planning guidance, reflecting our vision into the 21st century. We are bringing our long-range planning into focus in terms of the programming, planning and budgeting process.

## ARMY LONG-RANGE PLANNING GUIDANCE
## PLANNING AND PROGRAMMING TIME LINES




We have a debate on how to achieve our long-term goals. Chart 4 is a pictorial of those plans. The long-range research plan has been used for about 10 years. We have used it for long-range planning and we look from the technology base into systems development. The latest of these plans is shown at the bottom, which Mr. Singley will talk about. The Technology Base Master Plan, which we are very proud of because we think it is the starting point for the modernization plans.

## ARMY IMPERATIVES

- HIGH QUALITY SOLDIERS AND CIVILIANS
- REALISTIC, INTENSIVE TRAINING
- PROGRESSIVE LEADER DEVELOPMENT
- MODERN WARFIGHTING DOCTRINE
- MATERIEL SUPERIOR TO THREAT
- TECHNOLOGICAL SUPERIORITY
- ADEQUATE FACILITIES

On chart 5 are the modernization imperatives. Last year was the year of training and we trained intensively to keep our readiness edge. The better trained we are, the more deterrence we provide. We have active leadership in all components and a modern war-fighting doctrine we are very proud of.

We are going to focus on materials superior to the threat, technological superiority and superior facilities.

G12ɔZ.13

## ARMY MODERNIZATION STRATEGY

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## THREAT

✓ SOVIET MODERNIZATION:
- ➨ INCREASING
- ➨ QUANTITATIVE & QUALITATIVE
- ➨ COMMITTED & RESOURCED
- ➨ NEW SYSTEM FIELDED EVERY 7-8 YEARS

✓ INCREASING SOPHISTICATION OF SOVIET SURROGATE AND THIRD WORLD THREAT

G125Z.13

Chart 6 is one page on the threat. In the conventional equipment area Russia has not changed its intent. The number of design bureaus and divisions that will be facing us in the years to follow, we think, are just as formidable as today.

The Secretary General's draw-downs one might say is a plan for a leaner and more effective Soviet army and we think they are going to be tougher, not weaker.

We are looking at the reality of two future Soviet tanks arriving 7–8 years apart from one another. That is one of the realities of the block improvement programs to the Abrams Tank.

## OUR TOP NINE EQUIPMENT REQUIREMENTS

- ANTI-ARMOR
- COUNTERFIRE
- FORWARD AREA AIR DEFENSE
- MOBILITY
- SEE DEEP
- ATTACK DEEP
- REDUCE LOGISTICS TAIL
- COMMAND AND CONTROL
- CHEMICAL DETERRENCE

IN THE BEATEN ZONE ... SURVIVABILITY OF SYSTEMS

Chart 7 is the top nine requirements. They are not in prioritized order because we have to look at all the functions in the service. Anti-armor is placed as the number one priority in the Army R&D program. We have two force modernization options. This is a policy decision that the Department has taken in the past year.

## FORCE MODERNIZATION - THE OPTIONS

| MAJOR IMPROVEMENTS ACROSS THE ENTIRE ARMY EVERY 15 YEARS | IMPLICATIONS | BLOCK IMPROVE AND FIELD TO PORTION OF FORCE EVERY 5-6 YEARS |
|---|---|---|
| • RDTE EXPENDITURES RELATIVELY LOW | | • RDTE EXPENSES INCREASE TO SUPPORT CONCURRENT TECH BASE AND FSED EFFORTS |
| • FOCUS ON PROCUREMENT | | • PROCUREMENT QUANTITIES REDUCED TO PAY RDTE BILL |
| • RELATIVELY LOW FORCE TURBULENCE | | • HIGHER FORCE TURBULENCE |
| • M+10 FORCE PROBABLY OBSOLETE WHILE FIELDING FINAL FORCE PACKAGE | | • M+10 FORCE ALWAYS FAVORABLY MATCHED TO SOV COUNTERPART FROM QUAL. PERSPECTIVE |

On Chart 8 you will see that we could modernize sequentially through the force every 15 years. That means between when the first new tank arrived and the last of that new tank arrived to the

Reserve Components in the D-day plus 30 force, 15 years would have been taken in order to get all those tanks into the inventory.

We have made a conscious policy decision not to do that. We are going to modernize in thirds, which means every 5 to 7 years the first to fight forces, those in Germany, will receive the new tank and we will pass it down on a prioritized basis to those deployments below.

There are higher support costs required when you process a fleet of tanks three times in order to hand it off to the forces who arrive later in the deployment cycle. We want to be sure tank survivability and lethality against the Soviets is an absolute priority for the United States Army.

## ARMY FORCE MODERNIZATION APPROACH

- SUPPORT WARFIGHTING REQUIREMENTS
- FOCUSED, HARNESSED, STABLE TECH BASE
- LEVEL FUNDING ... NO BOW WAVE
- DEVELOP FUNCTIONAL MODERNIZATION PLANS
- RETAIN SYSTEM OF SYSTEMS
- MODERNIZE BY FORCE PACKAGE
- CONTROL AGE OF FLEET
- CONTROL OPERATING EXPENSE

Our approach to modernization is on Chart 9. We have taken a level funding approach to our family of modernization plans. We want to retain a system of systems as a concept so that we are building a family of vehicles or a family of weapons systems around a centerpiece and carry those through as a package.

I talked about modernizing by force package. That is our M plus 10 force, the 10 divisions we must have deployed to Germany in 10 days. The second is the 10 to 30 force and the third is the 30 days to end of war. We have taken on retiring our aging fleet. We have the Army Aviation Modernization Plan where we reduce the helicopter fleet from 8,600 to 6,600 helicopters to keep our inventory current.

Sir, I will not brief each of the charts 10 through 16. They are pictorials of the Army's modernization plans. They show the systems in armor and anti-armor, aviation, air defense, fire support, deep attack and tactical wheeled vehicles.

If I attempted to brief each, I fear I would use too much time. But I want to show you that we have done our homework. We put these plans together. The numbers are what is represented in the

Reagan fiscal year 1990–1991 budget. We will adjust these plans as we take a look at any budget reductions.

So we have our planning guidance in place and we have the ability to adjust various systems from where they are today. In some cases we may have to look at reductions from those systems. I think the continuity from the past to the future is laid out in these modernization plans.

## MEETING THE MID-TERM TANK REQUIREMENT

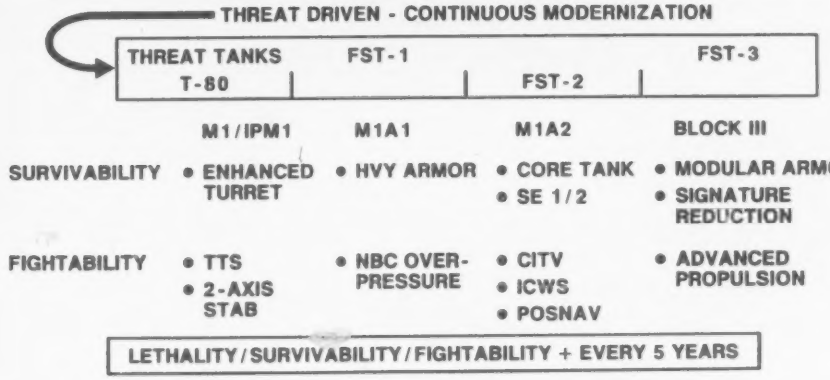



Chart 11, Meeting the Mid-Term Tank Requirement, the future Soviet Tanks FST–1 and FST–2 are alternating tanks that come off the two Soviet tank lines.

They leap-frog their development so that within their 15-year cycle, because they have two tank development processes in their country, a tank comes out about every 7–8 years. We are building the Abrams Block II tanks to get into the hands of our forward deployed M plus 10 forces so that we will have a product improved tank that is equipped for survivability and lethality.

We will be happy to explain the details of the block improvement programs as we get into questions and answers. The same follows in the far right-hand column. We are proposing Block III improvements to respond to their tank to turn our development cycle inside their fielding cycle.

G280.28

## ARMY TECHNOLOGY BASE MASTER PLAN (ATBMP) OBJECTIVES

- PROVIDE TOP DOWN GUIDANCE TO THE ARMY TECHNOLOGY BASE COMMUNITY
- ENHANCE THE LEVERAGING OF OTHER SERVICE, INDUSTRY & ACADEMIA INVESTMENT
- BE RESPONSIVE TO DA, OSD & CONGRESSIONAL GUIDANCE/ INTERESTS
- FOCUS MATERIEL DEVELOPER TECHNOLOGY BASE INVESTMENT- RELEVANT & RESOURCED AT CRITICAL MASS
- SIGNIFICANTLY IMPROVE TECHNOLOGY BASE STABILITY
- ACHIEVE MORE SUPPORT FOR THE TECHNOLOGY BASE INVESTMENT THROUGH AN IMPROVED UNDERSTANDING OF OUR INVESTMENT STRATEGY & PLANS

G280.28

Now if I may skip to page 17, the Army Technology Base Master Plan is the underpinning plan that supports the family of fielding plans in systems development. With me today is George Singley, who will brief you on the Technology Based Master Plan.

Mr. DELLUMS. Thank you.

STATEMENT OF GEORGE T. SINGLEY, DIRECTOR FOR ARMY RESEARCH & TECHNOLOGY, OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY, (RESEARCH, DEVELOPMENT AND ACQUISITION) DEPARTMENT OF THE ARMY

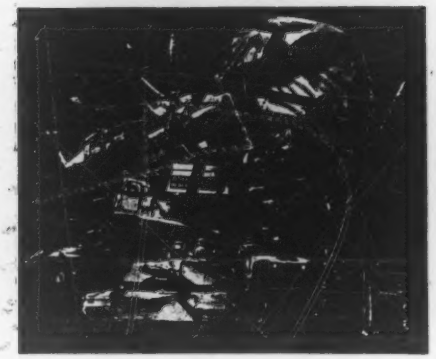
Mr. SINGLEY. Mr. Chairman and members of the committee, it is a distinct pleasure for me to be here today for my first time as Director for Army Research and Technology before this committee. I, like General Pihl, will only cover a portion of the charts which you have before you covering the technology base.

GEORGE SINGLEY

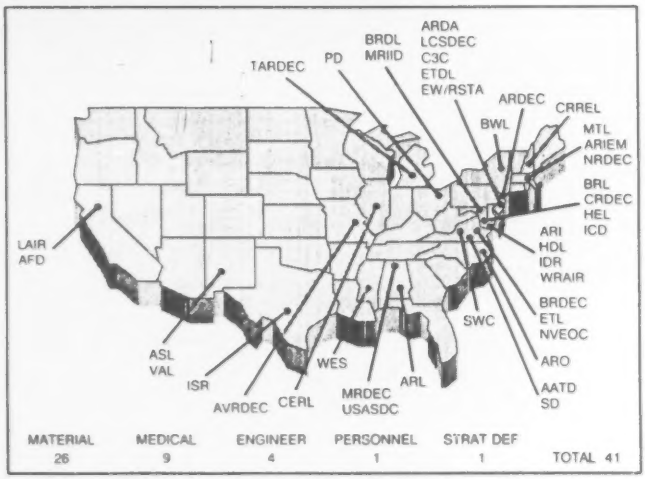
DIRECTOR,
RESEARCH &
TECHNOLOGY

OASA (RDA)
PENTAGON

## ARMY TECHNOLOGY BASE



## ARMY S&T RESOURCES




- LABS AND FIELD UNITS LOCATED IN 16 STATES AND DC
- 25,000 PEOPLE
- 10,000 SCIENTISTS AND ENGINEERS

Starting on Chart 2, I have laid out for your information, sir, the magnitude of the Army technology base. There are 41 Technology Base organizations. The Technology Base represents 22 percent in budget years 1990 and 1991 of the total Army RDT&E. Presently, we have approximately 1 percent of the Army's total obligation authority.

## ARMY TECHNOLOGY BASE MASTER PLAN

- TECHNOLOGY BASE INVESTMENT STRATEGY
- RESEARCH AND DEVELOPMENT BALANCE
- FOCUS ON CRITICAL/KEY EMERGING TECHNOLOGIES
- SPEEDING TECHNOLOGY TRANSITION
- LEVERAGING SCIENCE AND TECHNOLOGY OUTSIDE THE ARMY
- QUALITY SCIENTISTS AND ENGINEERS

SCIENCE AND TECHNOLOGY SUPERIORITY:
OUR INVESTMENT IN SHAPING THE FUTURE
AND COMPETING SUCCESSFULLY

On Chart 3, I would like to highlight for the committee a major initiative the Army has undertaken to focus and harness the technology base. The Army Technology Base Master Plan has been in formulation for the last 6 months. We are due to publish the plan next month, in April. It is our intent to provide that plan to the committee, the Congress and industry.

We feel it is very important that we not only focus the technology base within the Army laboratory system, but also that we help industry as they lay out their R&D plans to help focus their technical base.

In our investment strategy, leveraging sources outside the Army is an imperative. Within the Technology Base Master Plan, we present our technology base investment strategy which has been developed in coordination with the OSD effort to formulate the DOD technology base investment strategy.

A key is balancing research and development. Not only balancing basic research with exploratory development and advanced technology development, but we have to assure the proper transition out of the technology base into the modernization plans that General Pihl just mentioned in his testimony.

We have focused on a finite set of critical and key emerging technologies. You will see that within the Army we have focused on 13 key emerging technologies and I will comment on those later. We feel another imperative is to speed the transition of technology. Too often too many studies have found that in the technology base within the Department of Defense, we do not seem to be transitioning technology soon enough.

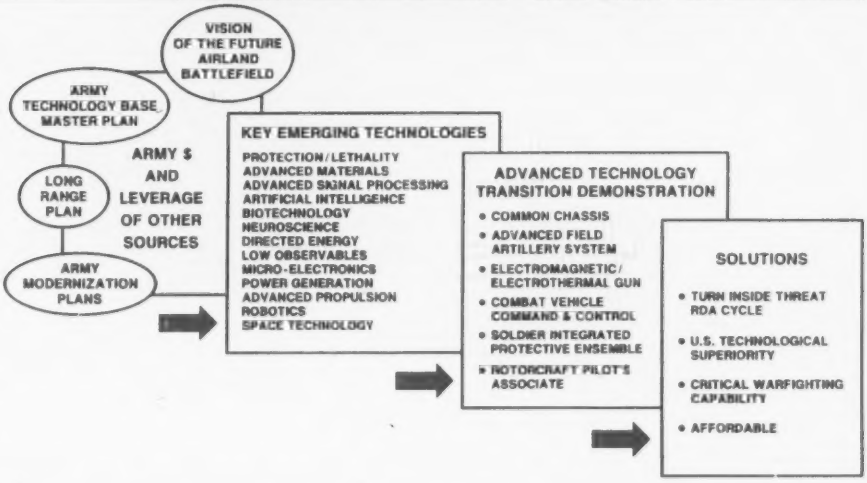
I want to talk about a new initiative that we have to speed the advance of technology to the field. It has three components, our plan, our demonstrations and the modernization plans that have been developed for the battlefield functional areas General Pihl mentioned earlier.

We feel we have to leverage science and technology outside the Army. In the projects in terms of what funds are available and the way technology is advancing, obviously there are technology areas of common interest where we can have joint programs, memoranda of understanding, help focus R&D, etcetera.

A very critical component of our science and technology program is the recruitment, retention and development of quality scientists and engineers in the Army as well as in the industries and universities we deal with. The Army Technology Base Master Plan is to help us achieve and retain our technological superiority and to achieve our vision of the future.

4

## ARMY TECHNOLOGY BASE STRATEGIC PLANNING INITIATIVE




On Chart 4, sir, we have laid out our science and technology strategic planning initiative. I would like to walk the committee through this briefly if I may. As we take our vision of the future, which has come from our AirLand Battle doctrine, input from the operational community, and the Army modernization plans mentioned earlier, these give us a vision of the future and windows of opportunity are identified so we can take snapshots of technologies emerging out of the labs and focus on demonstrations for future systems, the 13 key emerging technologies, and our basic research and exploratory development investment.

As we identify promising products out of exploratory development, we try to capture them in the form of advanced technology transition demonstrations. This enables us to turn inside the threat's RDA cycle because it enables us to develop technology and get it inserted into full-scale development quicker.

This strategy also insures the maintenance of our technological superiority within current funding levels. We have had to make tough choices in terms of prioritization and in terms of what is

going to be funded, not just in the budget year, but across the 5-year defense plan. We have had to make those tough choices and they are documented in the Science and Technology Objectives Annex to the Army Technology Base Master Plan.

We have had success in the area of technology demonstrations particularly in the case of aviation. I will not walk the committee through all our technology demonstrations, that have been successful, but I would like to highlight some, beginning with the Advance Technology Demonstrator Engine Program. That laid the technological foundation for the T800 engine for LHX. The primary and secondary composite structure technology for LHX was demonstrated in the advanced composite airframe program. The benefits shown on chart 5 have occurred as a result of the successful programs we have done in the aviation community.

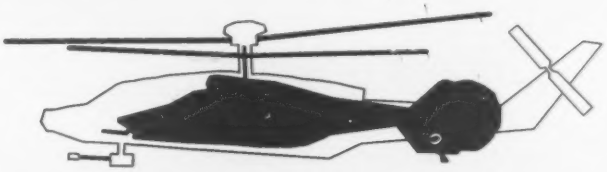
5

G280Z.43

## LHX ➧ ADVANCED TECHNOLOGY CONTRIBUTION

**ADVANCED TECHNOLOGIES APPLIED**

- ADVANCED ROTOR DESIGN
- ADVANCED COMPOSITE STRUCTURES
- FLY-BY-LIGHT FLIGHT CONTROL SYSTEM
- DRAG REDUCTION
- T800 ENGINE
- ADVANCED MISSION EQUIPMENT
- INTEGRATED/AUTOMATED COCKPIT



**PROJECTED LHX IMPROVEMENTS vs BLACK HAWK/APACHE TECHNOLOGY**

- LESS ENGINE POWER REQUIRED
- LIGHTER EMPTY WEIGHT
- LESS MISSION FUEL REQUIRED
- IMPROVEMENT IN PAYLOAD/GW RATIOS
- LIGHTER DESIGN GROSS WEIGHT

G280Z.43

It shows the kind of improvements we envision for LHX. Moving to the Advanced Technology Transition demonstrations on Chart 6, I tried to highlight here for the committee some of the Heavy Force Modernization technologies that are being demonstrated as a result of our common chassis Advanced Technology Transition Demonstrations and Component Advanced Technology Test bed funded in the President's budget.

G280Z.44

## BLOCK III TANK ➡ ADVANCED TECHNOLOGY CONTRIBUTION

G280Z.44

**ADVANCED TECHNOLOGIES APPLIED**

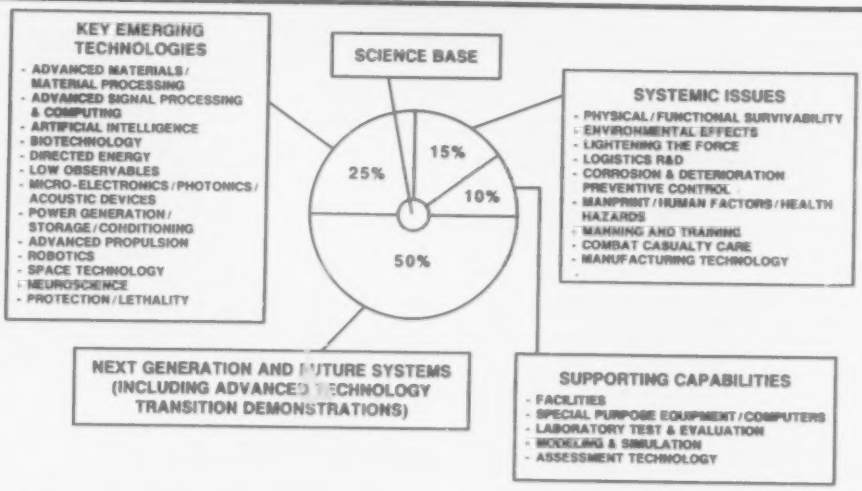
- ADVANCED TANK CANNON & AMMUNITION
- AUTOLOADER
- VHSIC FIRE CONTROL
- MODULAR ARMOR & COUNTERMEASURES
- ADVANCED INTEGRATED PROPULSION SYSTEM
- HYDROPNEUMATIC IN-ARM SUSPENSION
- ADVANCED TRACK
- MULTIPLE TARGET ACQUISITION SYSTEM

**PROJECTED BLOCK III IMPROVEMENTS vs M1A1 ABRAMS TECHNOLOGY**

- INCREASE IN ARMOR PENETRATION
- GREATER RATE OF FIRE
- IMPROVED, MODULAR ARMOR
- CREW SIZE REDUCED FROM 4 TO 3
- LESS PROPULSION SYSTEM VOLUME
- MORE SPROCKET HORSE POWER
- LESS BATTLEFIELD DAY FUEL REQUIRED
- REDUCTION IN TRACK AND SUSPENSION WEIGHT
- LONGER TRACK LIFE

The advanced tank cannon system, the advanced track and suspension technology, advanced propulsion and the application of advanced electronics to the main battle tank pose tremendous improvements on the horizon for the block III tank. For example, approximately 40 percent less propulsion system volume and the other benefits shown at the bottom, including reducing crew size from 4 to 3.

## TECHNOLOGY BASE RESOURCE DISTRIBUTION




On Chart 7 we have tried to lay out what the distribution of our resources is as we look across the 13 key emerging technologies; science base; systemic issues, such as safety, corrosion prevention, etcetera; supporting capabilities, which is after all the infrastructure of our R&D; and of course technology demonstrations in support of our next generation and future systems.

Sir, I have on the table to my left some examples of recent products that have come out of the technology base. I would like to point out some of those to you, if I may.

This is a material sample, sir, which you might have seen in this month's Armed Forces Journal, for our composite infantry fighting vehicle hull technology demonstrator which has a high glass content and achieves a 25 percent weight savings. This is as opposed to the current aluminum structure. This has been tested very successfully.

I have over here a model of a fiber optic gyro. This fiber optic gyro represents 60 percent less weight and less cost than what was currently in the Copperhead. In terms of volume and power it is in excess of 80 percent less.

I have here a polycarbonate pair of glasses with triple band laser eye protection for troops. This is the result of a group effort of not only our materials people, but the people at other labs as well. I have some photos which show the laser in terms of the blockage in three bands: green, ruby and infra red.

They offer not only protection against the emerging laser threat on the battlefield, but also some ballistic protection for the eyes. This is a wire-cutter off the top of an AH-64. This addresses a systemic issue the Army has incurred over the years in terms of wire strike protection.

These are on or are being retrofitted on most Army helicopters. They were also retrofitted on some U.S. Treasury helicopters and have prevented at least 15 accidents during recent field destruction operations in Mexico.

From 1974 to 1980 wire strikes accounted for 16 percent of our Army aviation fatalities. We have now achieved by use of these devices avoidance of approximately 6 helicopter accidents due to wire strikes. The engineer who worked on this project with the Canadians has received the Army R&D achievement award.

These are just few examples of what we are getting for our technology base investment. Now, going to the last chart. We feel there is quite a bit new this year in the Army technology base. We have an investment strategy. Our work is focused and we are working with the Office of the Secretary of Defense.

8

## ARMY TECHNOLOGY BASE

### WHAT IS NEW

- DOD SCIENCE AND TECHNOLOGY INVESTMENT STRATEGY EXECUTIVE COMMITTEE
- ARMY TECHNOLOGY BASE INVESTMENT STRATEGY (TBIS) AND MASTER PLAN
- ADVANCED TECHNOLOGY TRANSITION DEMONSTRATIONS (ATTDs) SPEED TECHNOLOGY TRANSITION TO TURN INSIDE THREAT RESEARCH, DEVELOPMENT AND ACQUISITION (RDA) CYCLE
- TECHNOLOGY BASE RESTRUCTURED TO SUPPORT MODERNIZATION PLANS
  - AVIATION MODERNIZATION PLAN
  - HEAVY FORCE MODERNIZATION PLAN
- SCIENCE AND TECHNOLOGY OBJECTIVES
- RESEARCH THRUSTS AND KEY EMERGING TECHNOLOGIES FOCUSED
- BOARD ON ARMY SCIENCE AND TECHNOLOGY (BAST) STUDY ON STRATEGIC TECHNOLOGY FOR THE ARMY (STAR)
- NEW CENTER OF EXCELLENCE (SUPERCOMPUTER)
- IMPROVE STABILITY FOR RESEARCH (6.1) AND EXPLORATORY DEVELOPMENT (6.2)
- LEVERAGING INDUSTRY, ACADEMIA, AND GOVERNMENT ORGANIZATIONS

Later this month, when OSD testifies on our DOD research program, you will see that the services are coordinating and working toward a common investment strategy. We have the Army Technology Base Plan. It has been coordinated. We plan to provide it to you. As I mentioned, it is an attempt to focus our technology base within the Army and outside.

I mentioned the advanced technology transition demonstrations and their promise in terms of speeding technology into our future systems. The aviation modernization plan you heard about last year. This year we are testifying about the heavy force modernization plan. I cannot overemphasize the importance of that to the technology base. In the past we had difficulty predicting what the windows of opportunity were for technology insertion. We now have a plan for heavy forces. We have some very specific science and technology objectives going out to the field as top down guidance as we prepare our next long-range RDA plan and budget.

This is not a static process. The Army Technology Base Master Plan is a living document. We have the Board on Army Science and Technology at the National Academy of Science reviewing our 13 key emerging technologies. If we have to make adjustments in our key emerging technologies list, we will do so. We have a new center of excellence, the Army High Performance Computing Research Center. We are trying to tap in to the leading edge of computer science.

One thing we have done also, sir, is to restore stability in the Army technology base program. We have assessed that the technology base needs to be stabilized. To that end we have established a funding floor of zero percent real growth for basic research and exploratory development. We hope to compete favorably for more than that, but we have the floor of zero percent real growth which is very important.

Finally, we must leverage organizations outside the Army. There are a lot of common areas of interest. We are pursuing this as I mentioned at the beginning of my testimony. Sir, this concludes my prepared remarks. I have attached two sections of additional charts which are labeled T1 and R1.

They go into more detail as to what the promise is for the key emerging technologies and the key elements of our basic research program. Thank you very much for your attention and the opportunity.

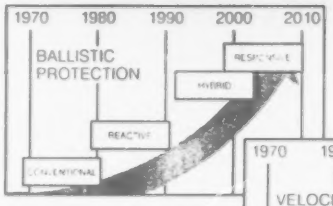
# KEY EMERGING TECHNOLOGIES

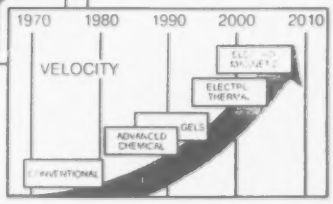
- PROTECTION / LETHALITY
- MICRO-ELECTRONICS / PHOTONICS / ACOUSTIC DEVICES
- ADVANCED SIGNAL PROCESSING AND COMPUTING
- ADVANCED MATERIALS / MATERIAL PROCESSING
- ADVANCED PROPULSION
- POWER GENERATION / STORAGE / CONDITIONING
- ARTIFICIAL INTELLIGENCE
- ROBOTICS
- DIRECTED ENERGY
- SPACE TECHNOLOGY
- LOW OBSERVABLES
- NEUROSCIENCE
- BIOTECHNOLOGY

## PROTECTION LETHALITY

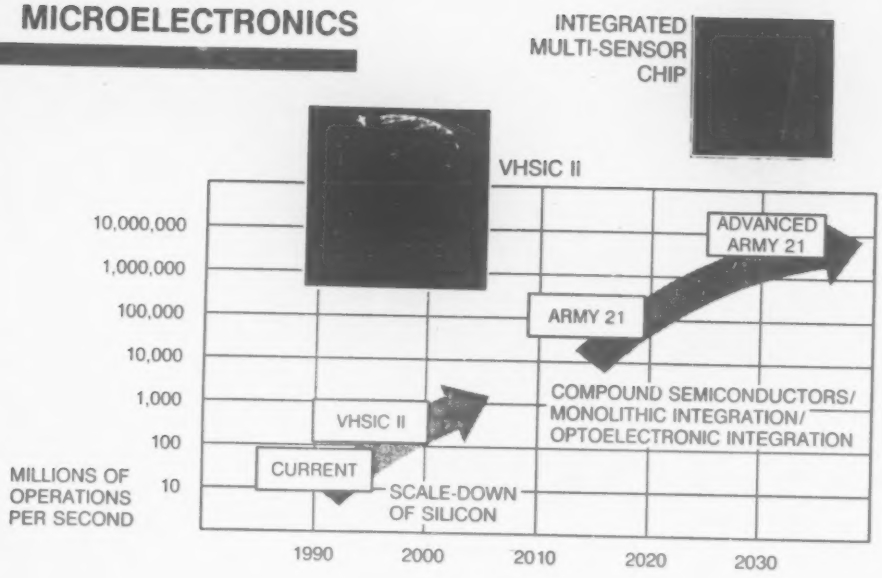
- HIT ADVOIDANCE
  - SIGNATURE REDUCTION
  - COUNTER ENEMY TARGET ACQUISITION
- HIGH PERFORMANCE ARMOR
  - LIGHTWEIGHT/HI-STRENGTH MATERIALS
  - UNCONVENTIONAL ARMOR
- DAMAGE TOLERANCE
  - MULTI-HIT CAPABILITY
  - FAIL-SOFT DESIGN
- KILL MECHANISMS
  - BRILLIANT MUNITIONS
  - SMART MINES
  - LOITER WEAPONS
- ADVANCED PROPULSION
  - ELECTROTHERMAL
  - ELECTROMAGNETIC
- HIGHLY MOBILE PLATFORMS
  - ROBOTICS
- ENERGETIC MATERIALS
  - PROPELLANTS
  - EXPLOSIVES

FINITE ELEMENT ANALYSIS OF IMPACT 3D COMPUTATION (1 = 25μs)



## MICROELECTRONICS




T-4

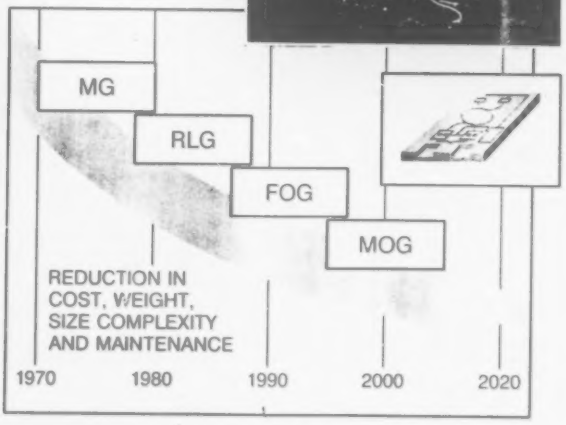
## PHOTONICS

### GYROSCOPES

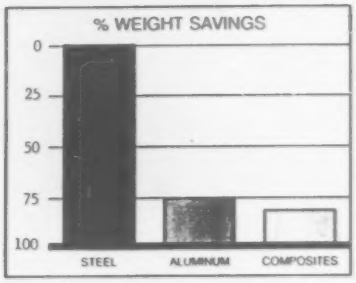
MECHANICAL GYRO

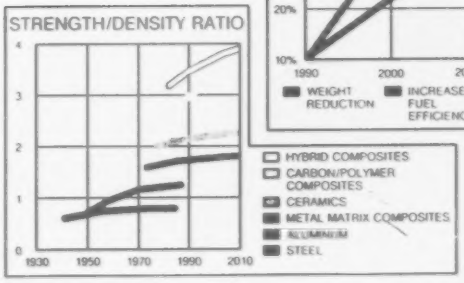
FIBER OPTIC GYRO

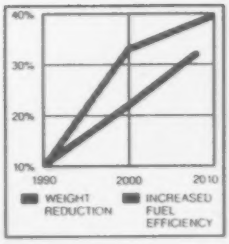
RING LASER GYRO



# ADVANCED MATERIALS AND MATERIALS PROCESSING




T-6

## COMBAT VEHICLE COMPOSITE HULL

MATERIALS TECHNOLOGY LABORATORY

US ARMY LABORATORY COMMAND

*OPPORTUNITY*

USE THICK GRP COMPOSITES INSTEAD OF METAL PLATES TO BUILD GROUND VEHICLES - 3 MOLDED PARTS REPLACE 23 WELDED PLATES

*FRONT GLACIS, UPPER SIDEWALLS, FLOOR, AND ROOF OF S-2 GLASS-POLYESTER; SIDE ARMOR OF CERAMIC TILE APPLIQUE & EXPANDED METAL OVER COMPOSITE*

*APPROACH*

PH. 1: SELECT DESIGN, MATERIAL, PROCESS & CURE; TEST SECTIONS
PH. 2 & 3: FABRICATE FULL HULL; OUTFIT & ROAD TEST (6000 mi.)

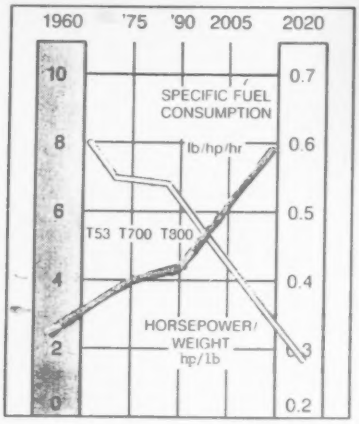
*PAY-OFFS*

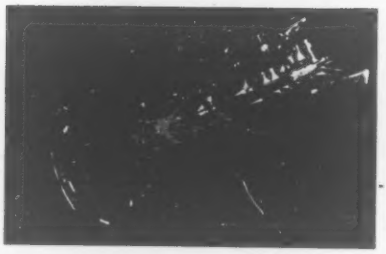
- 25% WT SAVING (hull & armor) at EQUAL BALLISTIC PROTECTION
- REDUCED SPALL (Survivability)
- NO CORROSION (Maintainability)
- SIGNATURE REDUCTION
- REDUCED LIFE CYCLE COST
- LOGISTICS IMPROVEMENTS

MOBILITY - TRANSPORTABILITY
LESS FUEL CONSUMPTION

T-7

## ADVANCED PROPULSION



**COMPRESSORS**
- HIGHER PRESSURE RATIOS
- COMPUTER AIDED FLOW ANALYSIS
- NONINTRUSIVE FLOW MEASUREMENT

**TURBINES**
- HIGHER WORK
- COMPUTER AIDED FLOW ANALYSIS
- BLADE COOLING CHANNELS

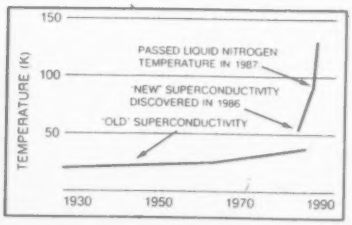
**COMBUSTORS**
- ADVANCED LINER COOLING SCHEMES
- CERAMICS
- PRIMARY ZONE DESIGN SHAPING

**OTHER ASPECTS**
- ENGINE CONTROL LAWS
- NEW SEAL AND BEARING DESIGNS
- POLYMER COMPOSITE CASINGS
- MODULAR CONSTRUCTION

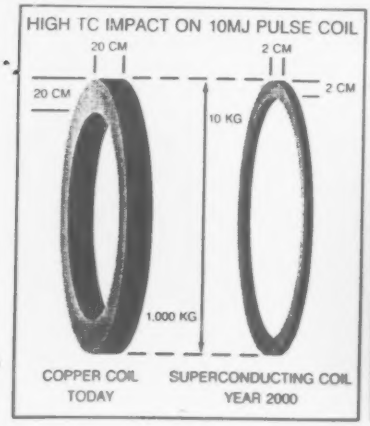
T-8

## POWER GENERATION, STORAGE AND CONDITIONING

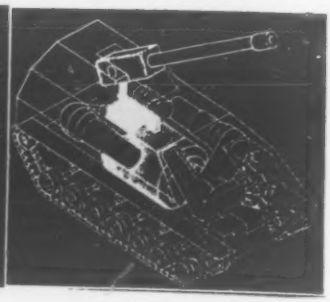
HIGH TEMPERATURE SUPER-CONDUCTIVITY PROGRESS




EM WEAPON SYSTEM



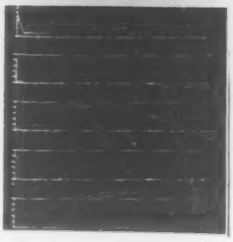

- POWER CONDITIONING SWITCHING
- TWIN TURBO-SHAFT ENGINES
- HOMOPOLAR GENERATOR
- EM ACCELERATE



T-9

## AI

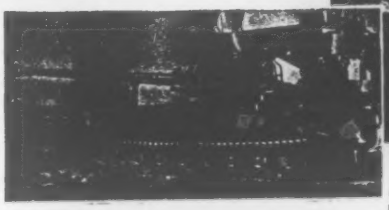
### PREVENT PILOT OVERLOADS THROUGH ANALYTICAL DESIGN AND EMBEDDED INTELLIGENCE



| | | | | | |
|---|---|---|---|---|---|
| **ALGORITHM DEVELOPMENT** | | | | | |
| MEMORY BASED REASONING | AUTOMATIC KNOWLEDGE ACQUISITION | COMPLEX PROBLEM SOLVING | | | |
| **SOFTWARE AND HARDWARE DEVELOPMENT** | | | | | |
| AI SHELLS FOR EXPERT SYSTEMS | DISTRIBUTED CONTROL | NEURAL NETWORKS | VISIONS | NATURAL LANGUAGE UNDERSTANDING | INTELLIGENT CONTROL SYSTEMS |
| **INTELLIGENT SYSTEMS** | | | | | |
| | SENSOR BASED LEARNING | | SELF ORGANIZING SYSTEMS | MAN MACHINE COMMUNICATIONS | |
| **ARMY APPLICATION** | | | | | |
| | INDIVIDUAL DIAGNOSTIC EXPERT SYSTEMS | MULTISENSOR FUSION | SYSTEM STATUS PROGNOSTICS SEMI AUTONOMOUS ROBOTIC VEHICLES | ATR | COCKPIT DRIVER ASSISTANCE | AUTONOMOUS SYSTEMS |
| 1980 | 1990 | 2000 | | 2010 | |

T-10

## ROBOTICS



AUTO LOADER

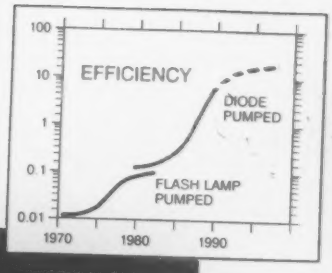
RECON VEHICLE

- VEHICLE AUTONOMY STRATEGIES
- RAPID MANIPULATION OF PAYLOADS
- STRUCTURES AND CONTROLS FOR HEAVY HAZARDOUS ITEMS
- ENVIRONMENT SENSING/ROUTE PLANNING
- COMMAND AND CONTROL OF MULTIPLE ROBOTIC VEHICLES

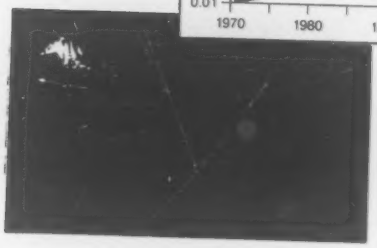
FMHRT

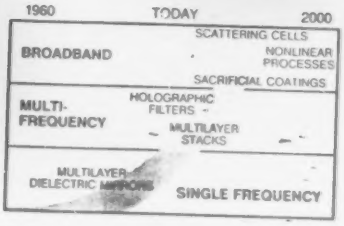
T-11

## DIRECTED ENERGY




PROTECTION






T-12

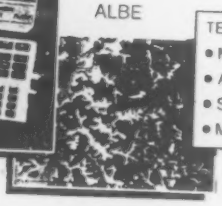
## SPACE

NAVIGATION & COMMUNICATIONS

GPS LOCATION
- 30-METERS CEP. CURRENT
- FIXED STATION LARGE ANTENNA

TECHNOLOGIES
- MICROELECTRONICS
- ECCM (ANTI-SAM)
- SIGNAL PROCESSING

LOCATION & COMMUNICATIONS
- GPS 1 METER CEP.
- VEHICLE-BORNE
- COMSAT SYSTEM



ALBE

TECHNOLOGIES
- MULTI SENSOR FUSION
- A.I.
- SIGNAL PROCESSING
- MICROELECTRONICS

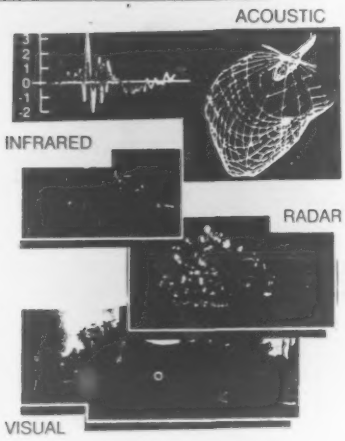
TACTICAL WEATHER INTELLIGENCE
- RAIN, RAIN RATE
- HUMIDITY PROFILE
- WIND PROFILES
- SOIL MOISTURE
- TRAFFICABILITY

GPS

REMOTE SENSING OF THE BATTLEFIELD

T-13

## LOW OBSERVABLES




TECHNOLOGIES
- SIGNATURE MODELING FOR OPTIMAL DESIGN
- RAM/RAS
- IR SUPPRESSION/ THERMAL MATCHING
- FILMS/COATINGS
- ACOUSTICS
- DECOYS
- CLUTTER/OBSCURANTS

EFFECTS
- ABSORB/ADSORB
- SCATTER/DISPERSE
- MASK/HIDE
- INTERFACE
- DISPLACE/SHIFT
- REFLECT/REFRACT

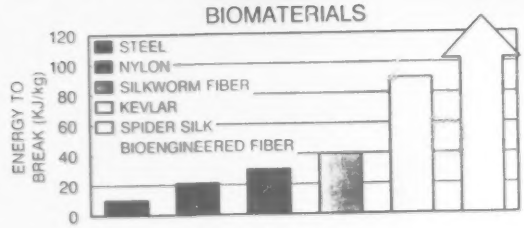
T-14

## BIOTECHNOLOGY

CB DEFENSE
- ENZYMATIC DECONTAMINATION
- REMOTE DETECTION
- BIOSENSORS
- REACTIVE FABRICS

MEDICAL
- VACCINES
- WOUND REPAIR
- BIORECEPTORS
- TEST KITS
- ARTIFICIAL BLOOD

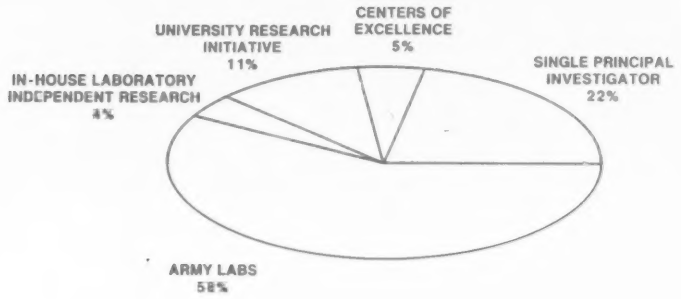
BIOMATERIALS



R-1

## PERCENT OF INVESTMENT - 6.1

POM 90-94


CENTERS OF EXCELLENCE 5%
UNIVERSITY RESEARCH INITIATIVE 11%
SINGLE PRINCIPAL INVESTIGATOR 22%
IN-HOUSE LABORATORY INDEPENDENT RESEARCH 4%
ARMY LABS 58%

R-2

## BASIC POLICY CONSIDERATIONS

- STRONG INTERACTION WITH OUTSIDE RESEARCH COMMUNITIES ESPECIALLY UNIVERSITIES, INDIVIDUAL INVESTIGATORS, AND CENTERS
- EACH LAB/CENTER HAS OWN 6.1 TO BRING RESEARCH TO APPLICATION AND TO ATTRACT AND RETAIN NEW AND HIGH LEVEL SCIENTIFIC COMPETENCE
- INTEGRATE ARMY LAB/CENTER RESEARCH PROGRAMS WITH THOSE SPONSORED AT UNIVERSITY THROUGH CENTERS AND INDUSTRY THROUGH IR&D

98-110 0 - 89 - 13

R-3

## CONTRIBUTIONS TO RESEARCH

- 1964 - PHYSICS; CHARLES TOWNES - MASER AND LASER
- 1972 - PHYSICS; JOHN BARDEEN - SUPERCONDUCTIVITY
- 1973 - PHYSICS; LEO ESAKI - ELECTRON TUNNELING
- 1976 - CHEMISTRY; WILLIAM N. LIPSCOMB - BORANE COMPOUNDS
- 1979 - CHEMISTRY; HERBERT C. BROWN - BORON AND PHOSPHOROUS COMPOUNDS
- 1981 - PHYSICS; ARTHUR SCHAWLOW - SOLID STATE LASER (LASER SPECTROSCOPY)
- 1981 - PHYSICS; NICHOLAS BLOEMBERGEN - NON-LINEAR OPTICS

R-4

## CENTERS OF EXCELLENCE

- ROTARY WING AERONAUTICS
  - GEORGIA TECH
  - MARYLAND
  - RENSSELAER POLY
- ARTIFICIAL INTELLIGENCE
  - PENNSYLVANIA (PHILADELPHIA)
  - TEXAS (AUSTIN)
- MATHEMATICS
  - CORNELL
- ELECTRONICS (TRI-SERVICE)
  - MIT
  - COLUMBIA
  - STANFORD
  - GEORGIA TECH
- ELECTRO-OPTICS
  - ROCHESTER
  - ARIZONA STATE
- ELECTRO-MECHANICS
  - TEXAS (AUSTIN)

R-5

# UNIVERSITY RESEARCH INITIATIVE ARMY CENTERS

| | |
|---|---|
| MANUFACTURING SCIENCE AND RELIABILITY AND MAINTAINABILITY ENHANCEMENT | - UNIVERSITY OF DELAWARE |
| ELECTRO-OPTICS, SIGNAL PROCESSING AND IMAGE UNDERSTANDING | - UNIVERSITY OF ROCHESTER |
| ADVANCED PROPULSION SYSTEMS | - UNIVERSITY OF WISCONSIN |
| GEOSCIENCES | - COLORADO STATE UNIVERSITY |
| FAST REACTION KINETICS OF ENERGETIC MATERIALS | - UNIVERSITY OF S. CALIFORNIA |
| INTELLIGENT CONTROL SYSTEMS | - MASSACHUSETTS INSTITUTE OF TECHNOLOGY<br>BROWN UNIVERSITY*<br>HARVARD UNIVERSITY* |
| HIGH FREQUENCY MICROELECTRONICS | - UNIVERSITY OF MICHIGAN |
| ULTRA DYNAMIC PERFORMANCE MATERIALS | - UNIVERSITY OF CALIFORNIA AT SAN DIEGO |
| BIOSYSTEMS AND BIOTECHNOLOGY | - CORNELL UNIVERSITY |
| ADVANCED CONSTRUCTION TECHNOLOGY | - MASSACHUSETTS INSTITUTE OF TECHNOLOGY<br>UNIVERSITY OF ILLINOIS |

*CONSORTIUM

R-6

# CONGRESSIONAL INTERESTS - 6.1

- US GRADUATE STUDENT FELLOWSHIP GRANTS (FY89 - $2.4M:)
  - ($1.25M URI)
  - ($1.15M DRS)
- BROADEN URI GEOGRAPHICAL BASE (FY89 - $1.25M FROM URI)
- ARMY HIGH PERFORMANCE COMPUTING RESEARCH CENTER (AHPCRC) (FY90 - $1.5M)

R-7

## SPECIAL PROGRAMS
## ARMY SCIENCE "OUTREACH"

- HISTORICALLY BLACK COLLEGE (HBC) PROGRAM
- YOUTH SCIENCE ACTIVITIES
- HIGH SCHOOL SCIENCE TEACHERS PROGRAM
- ARMY SUMMER UNIVERSITY FACULTY PROGRAM
- SHORT-TERM INNOVATIVE RESEARCH PROGRAM

Mr. DELLUMS. I thank each of you gentlemen for your opening remarks. The Chair would now yield to the Ranking Minority Member, Mr. Dickinson, in the event he has an opening statement or would like to question the witness.

Mr. DICKINSON. Thank you, Mr. Chairman.

I have a statement to submit for the record.

Mr. DELLUMS. Without objection.

[The following information was received for the record:]

PREPARED STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA

I join my Chairman in thanking our witnesses for appearing before the R&D Subcommittee today. I have always been a strong supporter of Army modernization efforts and, therefore, look forward to your testimony on the status of on-going programs and the overall fiscal year 1990 R&D request.

While the Army's fiscal year 1990 R&D request of $5.6 billion represents only about 50 percent of the Navy and 33 percent of the Air Force R&D requests, a number of important and controversial programs are involved. Although there is no Army money in this budget request for ASAT development, I understand that the Defense Acquisition Board recently decided that the Army should be the lead service on this program. I would be interested in hearing your views on the management approach as well as substance of this new ASAT effort. After several years of posturing and congressional direction, you have also requested funds for development of a Follow-On To LANCE—our aging, short-range nuclear missile in Europe. I would be interested in the Army's view of the requirement and how the proposed Follow-On system will satisfy it.

I would also ask that you provide the subcommittee updates on the LHX program, the status of anti-armor development, as well as an explanation of the status of your M-1 Tank upgrade program (Block 2 and Block 3).

The subcommittee has a lot to cover today, so I won't take any more of its time. We look forward to your testimony.

Thank you, Mr. Chairman.

Mr. DICKINSON. Dr. Sculley, I thought we got rid of you. What are you doing here?

Dr. SCULLEY. I have nine lives. It is a pleasure to reappear before the committee. I consider that a singular honor.

Mr. DICKINSON. It has been a pleasure working with you. I understand that you are going into private industry. I don't know in what capacity. You have really been a friend and great supporter of the Army and someone who I felt I could always count on. We will miss you very much.

Wherever you go, wherever you land, I wish you well and I hope you stay in touch. Any time I can be of assistance to you, and I am sure I speak for the whole committee, too, we want to do so.

Thank you for your appearance here today. It is good to see you.

I have a couple of questions. Dr. Sculley, you mentioned the glasses, which provide protection from a very real threat, as I see it, from lasers and other means on the battlefield. Can they be made to prescription? Can a person like me who normally has to wear glasses get them made to prescription to also have protection against laser?

LASER PROTECTION EYEGLASSES

Mr. SINGLEY. Yes. I believe they can, sir. These particular glasses, of course, are not prescription.

Mr. DICKINSON. I think that is very important. When we are talking about helicopters or tanks, the soldier on the battlefield, we are more and more concerned about protection against blinding by laser. I wonder if they were made so they could be used with prescription as well as just for the fellow who is fortunate enough not to need them. Do you know, Dr. Sculley?

Dr. SCULLEY. They have that potential, but these were originally developed for those front line troops who do not wear glasses. The early prototypes, which are similar to what you have today were produced at a cost in the $20 range. I am not familiar with the cost today as a result of a modest inflation, but they are essentially, as you can see, easy to produce. They are made from a polycarbonate material and I think attractive enough in appearance that our soldiers will really wear them.

Mr. DICKINSON. We are faced with, as was mentioned in the formal presentation here, probably a zero growth in our R&D or in the total defense budget. Pragmatically, I think we all agree we may end up with a flat budget. How does Army R&D fare in the total picture? Would you take your proportionate hits and would you take a negative growth if the total Army budget should be that way?

How do you envision this? It is my concern because R&D is not an area where we can sustain a zero growth, maybe in procurement or other areas, but not research and development because this gives us our cutting edge. I would hate to see us receiving less in research and development in proportion to the other elements of the budget, so I would like a response.

Dr. SCULLEY. I will have General Pihl provide some detail, but even in view of an austere fiscal environment under which we operate and given the fact that in real terms the total Army budget has declined in the last 5 years in a real sense, as I have outlined, I think that the R&D community and the spokesmen here at the table have provided the voice within the Army to protect the investment in research, development, test and evaluation. It is not

that we could not use more and use it wisely. I would not want to leave that impression, but as accounts go in the Army budget, I think we fared reasonably well.

General PIHL. In the 1989 budget we forwarded to the Congress last year you will recall the $10 billion decrement that occurred. By legislative agreement, the Army got back $6 billion as we were debating our proposal. Of that, $5 billion went into R&D. Of the $20 billion I am responsible for, we have protected the $1.2 billion in the technology base Mr. Singley talked about. So far in our deliberations we have not had to tamper with the R&D technology base in terms of a"give-up" and it is my intention to protect that because it is so vital to our future.

Other than the major systems we are looking at in terms of modernization, the numbers of helicopters, tanks, missiles we are going to be able to buy, under whatever scenario unfolds in the reduced budget, are presently on the chopping block. I don't think there is any question about that. As we look at our choices, we now see a severe cut.

Mr. DICKINSON. Mr. Chairman, will we have an opportunity to get into more detail into the various systems of the Army R&D?

Mr. DELLUMS. Not at this time. Maybe after the budget is done—after the Bush revised budget.

Mr. DICKINSON. We have LHX, FOG-M, a new tank.

Mr. DELLUMS. The witnesses are prepared to respond to these kinds of questions this morning because many of these programs will, I assume, be in the Bush administration budget request to go forward.

TANKS

Mr. DICKINSON. I don't want to take more than my share of time. let me ask one more question. We have been working with the tank program for I don't know how long. Now you are coming up with a Block III, whatever that is.

We have never produced the M-1 in the numbers that were projected when we were first given the unit price back when Mr. Carter was President and Mr. Alexander was Secretary of the Army. We were providing for a ramp-up when we facilitated the second production unit. But we never reached the projected rate that we were told.

Now we are talking about going to another type. Can you discuss this very briefly? How many tanks are we producing now—about one/fifth or 20 percent of what the Soviets are producing? Now, we are talking about going to another tank when we have not even produced enough of what we have to provide for the Guard and the Reserve and the active unit community.

Will you give us a brief comment on that?

General PIHL. Yes, sir. When I first came to research and development as a general officer in 1980, we had a procurement objective of 7058 M-1 battle tanks.

Mr. DICKINSON. Total?

General PIHL. Total. We now find our requirements will exceed 9,000 tanks. We are facilitized to $1,440 tanks a year. The present

request this year calls for 603 tanks. That is a measure of the rate that you discussed.

Mr. DICKINSON. Then you scaled that way down from what we were told earlier.

General PIHL. Budget decrements have caused us to hit these items in the budget. It is not desirable to do that because we need to modernize the tank force. I want to be sure that you understand the reason for the Block II tank even though it is a more expensive item. It is to insure the fightability of the M-1.

The tank commander must independently perform the target acquisition task so that you are doubling the rate at which you are killing enemy tanks. So the centerpiece of the Block II tank is the tank commander's viewer which allows him to function independently from the gunner so that when the gunner is killing one tank on his right, the commander is looking for the next tank on his left.

Because we are outnumbered and they are producing more tanks than we are, we have to double the kill capability.

Mr. DICKINSON. We don't have that capability now to identify one tank while somebody is shooting another.

General PIHL. Not unless he wants to get halfway out of the turret exposing himself to enemy fire. Leopard II has an independent commander station, the English tank will have an independent commander station, we cannot permit a tank like the M-1 not to have that capability.

Mr. DICKINSON. Your statement says that procurement quantities will be reduced to pay for the RDT&E bill. That doesn't make a lot of sense. Can you comment?

General PIHL. Well, we are trying to protect the R&D in the future to make sure we are able to modernize the rates of systems in procurement. That is the $15 billion that we are looking at for reduction. We don't want to mortgage our future.

Mr. DICKINSON. Things have been badly misrepresented to us in the past about the rates of production, unit costs. I yield back my time, Mr. Chairman.

Mr. DELLUMS. The Chair now recognizes Mr. Darden for such time as he might require.

Mr. DARDEN. Thank you very much. I want to welcome our panel this morning.

General Pihl, it is good to see you and Dr. Sculley again. Mr. Singley, we are glad to see you also. Some of us are concerned about the 6.1 and 6.2 functions. While we have been given a lot of lip service for it, we have about $700 million set aside. Do you believe this represents an elaborate technology base fund for the Army?

Don't you think we ought to try to make this program more robust?

### TECHNOLOGY BASE

Mr. SINGLEY. Yes, sir. The problem you point out, the 6.1 and 6.2 program has decreased 40 percent as a percentage of Army Total Obligation Authority over the last 15 years.

Mr. DARDEN. Isn't this disturbing to you to come on the job and find that out?

Mr. SINGLEY. I am concerned, but in the preparation of the budget the Army leadership arrested that decline. We have established a 6.1 plus 6.2 funding floor of zero percent real growth. There has been a steady decline over the last 15 years, but it has now been arrested despite a challenging austere fiscal environment. I tried to point out that we see that is a floor. That is a 6.1 plus 6.2 funding floor the Army has signed up to.

In the recent budget deliberations that General Pihl referred to, the technology base has not been cut thus far. I see that as an encouraging sign. I look forward over the next year or so as we put together the next budget and defend this one that we can compete for more additional funds.

Mr. DARDEN. I assure you, you will find a lot of sentiment on this committee to improve the situation.

Mr. SINGLEY. Thank you.

Mr. DARDEN. I am going to follow the precedent, which I think is a good one, set by Mr. Dickinson, and not go into too much detail on weapon systems. But there is one I would like to ask about, and then submit a list of questions.

Mr. DELLUMS. Without objection.

### AAWS-M/DRAGON

Mr. DARDEN. Gentlemen, we hear over and over that the most critical, embarrassing problem that the Army has right now is that it cannot kill the Soviet tank. This is not a big secret. Whenever the think tanks and the defense experts get together, they all say we can't kill the Soviet tank.

We have all signed aboard with the AAWS-M. We realize once it comes into place that this will be the grunt's dream. We all believe the AAWS-M system will be the solution. However, we are faced with the situation that today we cannot kill a Soviet tank. Accordingly, we have read rumors that Army has turned down two superior systems just to buy a cheaper system, which is, if not the legitimate son of Dragon, the illegitimate son of Dragon, known as Dragon II.

I heard complaints in the fields that the Dragon is not capable of filling the need. As a result of many congressional concerns last year, as you know, we wrote into the law both authorizations and appropriations, specific directions to the Department of Defense. Chairman Aspin even wrote to Secretary Marsh on October 26, 1988, his belief that certain Army units receive benefit of the medium range anti-tank system that has better survivability than the current Dragon system.

We understand that the Dragon II has less than a 1,000 meter range. There is no gunner survivability. Its kill ratio is probably the lowest of any systems tested. Again, I will submit questions in more detail, but please tell us it is not true that we are going to buy some more Dragons and if so on what basis was that decision made?

General PIHL. The decision made in 1985 was to improve the Dragon weapon system. We currently own 34,000 Dragon systems.

Its capability has been overtaken by the threat. We are only going to put on a warhead improvement. We are not changing the sight or buying new equipment. The choice for the Army is obviously the AAWS-M. We are very pleased with the Texas Instruments Martin Marietta team and what they offer us in the 2,000 meter, top attack system at an affordable price.

It is our intent to carry the product-improved Dragon in the force with its improved warhead. It does have survivability problems as far as the infantryman is concerned. But the risk in bridging the gap between Dragon II and the AAWS-M system fielding is a prudent one and we are going to rush to get AAWS-M into our inventories.

The question is how far. Are you going to equip the 18th Airborne Corpswith another system while waiting for AAWS-M? We look at the price tag for that, roughly $150 million. We would like to skip the interim step.

Mr. DARDEN. Without being argumentative, let me remind you that the act says the Army should procure the most effective system from the systems identified by law. It was not to keep this. There is the Milan II, a Bofors Bill. Don't both have superior range and superior kill ratios?

General PIHL. Sir, the two systems you are referring to, the Bill and the Milan have been tested by the Army. Those test results are being organized into a report that will be delivered to the Congress. The question is how we fight. The Dragon system for the United States Army is what we call an arm's room weapon.

It can be used by any soldier with a minimum of training. We do not dedicate a gunner to the Dragon, unlike the Marine Corps. We have systems like the tank cannon and the TOW missile system we rely on. The Dragon system at the present time can be product improved, as I mentioned.

If you were to procure a Milan or Bill, you would have to put a crew-served weapon in the field. We would have to dedicate gunners, train them on the system. I realize the two countries who made those systems are proud of them. Any comments I would make about the Swedes or the French would not be appropriate.

Mr. DARDEN. Thank you again. I will provide my other questions for the record.

Mr. DELLUMS. Thank you. Mr. Kyl.

Mr. KYL. Thank you, Mr. Chairman.

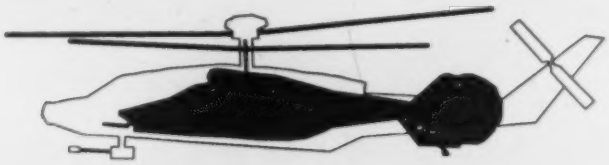
I will ask about two specific systems. I would like to have you describe for us your perception now of the advantages of the LHX over current inventories, particularly given the high cost of the LHX.

G280Z.43

## LHX ➧ ADVANCED TECHNOLOGY CONTRIBUTION

**ADVANCED TECHNOLOGIES APPLIED**

- ADVANCED ROTOR DESIGN
- ADVANCED COMPOSITE STRUCTURES
- FLY-BY-LIGHT FLIGHT CONTROL SYSTEM
- DRAG REDUCTION
- T800 ENGINE
- ADVANCED MISSION EQUIPMENT
- INTEGRATED/AUTOMATED COCKPIT



**PROJECTED LHX IMPROVEMENTS vs BLACK HAWK/APACHE TECHNOLOGY**

- LESS ENGINE POWER REQUIRED
- LIGHTER EMPTY WEIGHT
- LESS MISSION FUEL REQUIRED
- IMPROVEMENT IN PAYLOAD/GW RATIOS
- LIGHTER DESIGN GROSS WEIGHT

G280Z.43

LHX

Dr. SCULLEY. It might be appropriate to use a chart used by Mr. Singley in his testimony. I will find that number. It is chart Number 5. That shows the projected LHX improvement over the Blackhawk and Apache technology. Further, I would add that we do have a design-to-cost, unit flyaway cost goal of some $7.5 million per aircraft for the LHX.

It is greatly improved in its survivability. It is greatly improved in its ability to be repaired from battle damage and fight another day. It costs less on a unit basis than does the Apache.

Mr. KYL. If I could interrupt, that is comparing the Apache, which is a developed and deployed weapon right now which, in the minds of some, continues to be a very effective weapon for a long time. My question is whether we get $66 billion worth of new capability out of the LHX.

That is a lot of money. I understand there are improvements. They appear to be somewhat marginal. When you add them up I am sure they are significant. The question is whether we get $66 billion worth of new war fighting capability. Is it worth that price compared to the weapons we have now?

General PIHL. Yes, sir, I believe so. It allows us to retire with those 2,000 LHX aircraft: the AH-1 Cobra helicopter—a Vietnam vintage tank killer—and unarmed OH-6 and OH-58A/C's. We are always going to have a scout/attack team on the battlefield. We have looked to the LHX to perform the armed reconnaissance and scout role on the battlefield so that when you have acquired a large formation of enemy armor or enemy helicopters you will be able to have your scout team function properly.

When LHX comes into inventory it will carry almost as much ordinance than the Apache does.

Mr. KYL. Can you describe for us how you are developing that now compared to the AAWWS? If I am wrong, correct me.

General PIHL. The Airborne Adverse Weather Weapon System, AAWWS. We are trying to get the AAWWS, which includes the fire and forget Hellfire program, integrated into the Apache and then into the LHX. It is the AAWWS capability, given the low observability of the LHX and its ability to avoid being detected by the other side, using their SA-14, that makes the LHX a formidable weapon system.

The LHX will be able to deliver a fire and forget Hellfire on the battlefield. The mission equipment packages we are developing will be retrofitted into the Apache. That is the technology that flows back into our current inventory.

George, do you want to amplify that?

Mr. SINGLEY. One of the additional benefits of the LHX is the integrated automated cockpit. It is single pilot operable, although it has two seats. It has aided target recognition. It will have the state of the art integrated cockpit which is so promising that it will be the plan to have that retrofitted into the Apache Program.

The LHX is seen as a complement to the heavier side of the force. The LHX is a replacement for the aging, more than 20 years old, light fleet, AH-1 and OH-58. When one looks at the cost, I believe you have to look at the cost of not just procuring LHX, but the cost of what it would take to procure similarly effective weapons.

Mr. DICKINSON. Will the gentleman yield for this observation?

Mr. KYL. Certainly.

Mr. DICKINSON. One factor is that the Apache is in production as the most formidable weapon system that we have. We have an LHX system for 1995 that is somewhat optimistic.

So we are talking about something 5 or 6 years out there. I would like anybody who would to respond to that. Has the plan slipped?

Dr. SCULLEY. They are not competitive, but probably could be best described as complementary. Each are integral pieces of an aviation modernization program, which in our projection of the future is affordable. I would be happy to provide details of our best estimates on cost for the roughly 2,000 LHX's projected. I believe that figure is closer to $40 billion over the life of the program.

I might also point out that a very important program in a sister service is the C-17 program.

### C-17 PROGRAM

The Army needs the C-17 program. By comparison in that period the costs of the entire Army aviation modernization program and that of the C-17 are roughly comparable. I think with LHX, continued modernization of the OH-58 scout, continued modernization of the AH-64, continued production of the UH-60 and continued modernization of the CH-47, gives us an appropriate balance of continued existing programs yet modernization for the future.

Mr. KYL. Is that $48 billion then-year dollars or now-year dollars?

LHX

General PIHL. Yes, sir. When I said "yes, I believe so," when we reduced the program on a life cycle cost basis the program went from $66 billion down to $42 billion. We made the decision not to use the utility version. I should have addressed that in my answer.

Mr. KYL. Perhaps we could get a clear indication for the record of both now and later dollars. I would appreciate that.

[The following information was received for the record:]

LHX

QUESTION. Perhaps we could get a clear indication for the record of both now and later dollars (of program costs for the LHX).

General PIHL. Program costs for the LHX in fiscal year 1989 and escalated dollars are as follows:

[In billions of dollars]

| | Fiscal year 1989 | Escalated dollars |
|---|---|---|
| RDT&E total | 3.5 | 3.8 |
| Procurement total | 27.5 | 38.6 |
| Program total | 31.0 | 42.0 |

What would be the optimum period in which we could make a decision on the Follow-On to LANCE.

FOLLOW-ON TO LANCE

General PIHL. It is a two-part decision. We are currently in study. We have Follow-On To LANCE as a new start. The second is a deployment decision which has been discussed in recent months. We have more forces than just SACEUR where we could use the Follow-On To LANCE Capability.

We would like to pursue the requirement the Army has for all our forces, and then leave the deployment decision as a separate matter. We will enter full-scale development next year.

Mr. KYL. Thank you.

Mr. DELLUMS. Mr. McCurdy is recognized for such time as he may consume.

Mr. MCCURDY. Mr. Chairman, I, too, want to wish Dr. Sculley well. As a matter of fact, at this point, I would like to commend the gentlemen at the table, but also the Army for improving its presentation over the last 9 years.

If you look at the manner in which the presentation has been made, I think it has kind of creeped up over the last 10 years. In the early years, there was a hodge-podge of systems out there, and we talked about this weapon versus that one.

But now you see they are being packaged in concepts, and they have a mission statement which is clear. It is easier for the Members to follow when you turn to the chart and see the systems with the time line and actual quantities.

We have not had that in the past. I think you are making a lot of progress, and we certainly commend you for that. It makes it more understandable, and, then in the long term it is easier to support. I think the Army will benefit by the manner of its presentation.

With that, I would like to go into some specifics. In looking first at the armor/anti-armor issue, which has been covered in some detail, one of the systems that I have been concerned about—and I went to see a test at White Sands—is the LOSAT. Now, you call it that, but it was originally known as LBM, HVM and this Line-Of-Sight Anti-Tank weapon was accelerated in 1988.

Can you tell us where you see that going, and what decision points are facing you in that?

LOSAT

General PIHL. The Line-Of-Sight Anti-Tank weapon is a replacement for the Infantry TOW vehicle, which is a dedicated anti-armor that we have in the mechanized infantry. It will take the Hypervelocity missile and install that on a Bradley chassis to become the Line-of-Sight-Anti-tank weapon system. It is the earliest system in the six vehicles in package 1 of the Heavy Force Modernization Plan.

We look forward to getting it. It is the highest risk of the six systems. It is early in the test program phase.

I am not concerned that they will not be able to correct the problems that they have and continue with successful accomplishment. We need that weapon system in our dedicated anti-armor forces.

Mr. MCCURDY. It does not have a warhead, per se. It accelerates as it proceeds, as opposed to losing velocity.

General PIHL. That is correct. Picture a baseball bat flying at the same speed as the anti-tank weapon, and it will give you a visual idea of what this weapon represents.

Mr. MCCURDY. It is the first major step up in the ability to kill tanks?

General PIHL. That is correct.

Mr. MCCURDY. In fire support, you have armor and anti-armor included in fire support, as well as the MLRS and HIP. Would you walk us through those, if you would? Tell us the status of the HIP program. Does the 1990 budget request meet the minimum sustaining rate on HIP? I see that it is page 10 of your chart book.

HOWITZER IMPROVEMENT PROGRAM

General PIHL. The minimum economic rate is 20 Howitzers per month. The current minimum sustainment rate is six per month, and maximum production rate is 40 per month. The 1990 budget requests 40, so we are operating at well below minimum sustainment production rate as far as conversion.

The total planned procurement is 1700 Howitzers, and 1989 is the initial year of production for the first 19.

Mr. MCCURDY. The MLRS has been a success story not often stated, but it has been a true success story. Tell us where the SADARM and TGWs fit with that.

MLRS/SADARM/TGW

General PIHL. The Multiple Launch Rocket System and basic rocket——

Mr. MCCURDY. General, I think it is good for the record, we get hung up on these acronyms. Tell us what that means, for the committee.

General PIHL. Okay. I was going to walk you through from the basic end, the dual purpose improved conventional munition is our MLRS, which is fielded today. The Sense and Destroy Armor munition, SADARM is a smart submunition for MLRS and ISSMM, which is currently undergoing congressionally directed proof-of-principle demonstration firings with modified development hardware, and we are working with Honeywell and Aerojet.

We look to a fielding of the SADARM in the MLRS during fiscal year 1994, and in the 155mm howitzer during fiscal year 1993. The Terminal Guidance Warhead, TGW program, is an international development being worked with the four partners who are the four countries involved in the Multiple Launch Rocket System.

We have just currently transitioned to system development from component development with our partners. We have other negotiations in June before we look at full-scale engineering development for the Terminal Guidance Warhead program.

Mr. MCCURDY. Both these systems attack from the top, fly over and explode?

General PIHL. That is correct. The current MLRS rocket is an area weapon. The Sense and Destroy Armor, SADARM, is a self-forging fragment where the individual submunition finds the target and shoots an explosively formed penetrator down through the top of the tank.

Mr. MCCURDY. Are there show-stoppers technically in any of these?

General PIHL. Yes, sir. In terms of the current work on SADARM, in our Congressional demonstration firings in the 8-inch artillery piece. It is a software issue, but we have to make sure the algorithms are on target.

Mr. MCCURDY. Do you have a date for that?

General PIHL. SADARM goes through a full-scale engineering milestone decision in a year, yes.

ATACMS

Mr. MCCURDY. The ATACMS are showing good results. One of the questions raised during previous hearings was the Army's requirement of actual numbers of systems that should be developed.

Has the Army settled on numbers, and what are those for the record?

General PIHL. Sir, we have. We have taken a look at the family of deep attack programs, some of which are classified, and I will not speak to them in the open session, but we have taken a look at the targets in the battlefield.

We will procure out to 2834 of the ATACMS with the anti-personnel, anti-material submunition. They will be complemented by a mix of other systems that I could talk about in closed session.

Mr. MCCURDY. But the basic answer is that the Army has come forward with the fighting requirements?

General PIHL. That is correct. We have a Cost and Operational Effectiveness Analysis for the deep attack programs. It is not yet finally printed, but the emerging results have given us an indication for the fiscal year 1990 budget.

Mr. MCCURDY. If I recall, we imposed that language.

General PIHL. We must produce that COEA and deliver it to Congress by June, that is right, sir.

Mr. MCCURDY. On the artillery, with the signing of the INF Treaty, there has been some question raised as to the deployment of those troops and the support personnel for the P-IIs in Europe. What is the current Army thinking or plans as far as backfilling?

Do you intend to take MLRS detachments and offset the reductions in the INF, or do you intend to bring the INF troops home? Are you in a position to answer that?

General PIHL. Yes, sir. The Army intention is to convert them into a Multiple Launch Rocket System units. We would like to take the Pershing Battalion at Schweibisch Gmeund and have them become a part of that force. The last comment about ATACMS, the rocket-launched system, of course, is that it is our weapon centerpiece as far as middle and deep fires is concerned. We need to increase the conventional capability, as was mentioned in last year's Defense Science Board Study on Fire Support, and to respond to what we know about the preponderance of Soviet artillery.

Mr. MCCURDY. Is it not true that the assessment report from the Chairman of the Joint Chiefs of Staff last year and more likely than not this year continues to have the top 40 priorities? Counterfire and MLRS would be one of the ways to address that deficiency?

General PIHL. That is correct.

### AT-4/MPIM

Mr. MCCURDY. Last, Mr. Chairman, I notice on the chart here we have the AT-4 listed. I always thought it was an interim system. Gentlemen, we currently are having proof of principle testing on a multi-purpose individual munition, and I would like to know, does the Army have a requirement for basic urban fighting bunker-busting weapons since we are in proof of principle tests?

General PIHL. Yes, sir, the Army has a requirement for the Multi-Purpose Individual Munition. We are looking at two attack mechanisms, shoulder-fired and rifle-launched. We have proof-of-principle contracts with three contractor firms. When we addressed the affordability in the deliberations for the 1990 to 1991 budget, we made the decision to terminate the program after proof of principle testing is completed, select a technology, and put it on the shelf, not a choice that was really optimal for us, but one we had to make based on affordability.

Mr. MCCURDY. Do these tests reveal that the system is available to meet the Army's requirement?

General PIHL. Yes, we believe there is a system.

Mr. MCCURDY. The system failure would be a follow-on to AT-4?

General PIHL. Yes, sir.

M-9 PISTOL

Mr. McCURDY. There was a rumor floating on the street for a while about the M-9, that there were cracks and all kinds of problems and it was a procurement problem. I meant to say 9-millimeter. Is it resolved? Is there anything going on in that? Can you tell us where we are? It is not exactly one we usually get to in these hearings.

Dr. SCULLEY. I understand. The answer to the question is, yes, there are cracks. The most recent and rather tragic event, that occurred after firing just in excess of 2400 rounds, involved a young Marine on the Lackland, Texas range. This certainly was completely unexpected, and immediately, a safety of use message was issued restricting the number of firings before slide replacement to 1,000 rounds.

The Army position is that this is a latent defect incurred in the manufacture of the slide. I currently have a team from the Army Science Board investigating the incident, and attempting to determine the root cause of the slide failures. Their report is due to me next week.

Again, the Army position is that it is a latent defect, and currently a program of an improved slide is in production on models being issued this month, with the plan then to retrofit all previously produced models.

Mr. McCURDY. Mr. Chairman, I would like to submit for the record some questions on the FAASV, the AFATDS and how the decision was made within the building for the Army to take over the role of ASAT. Basically what that program is going to entail, and how comprehensive it is. Is it system-wide or just Army? How will that be handled?

Mr. DELLUMS. Without objection, the questions will be forwarded to you for your written response.

The Chair now recognizes Mr. Hertel.

Mr. HERTEL. Thank you, Mr. Chairman.

I will follow on Mr. Dickinson's questions with regard to the M-1 tank, and take your advice that we cannot get into detail in these problems today.

Does the Army stand beside the assertion——

Mr. DELLUMS. If you would yield, the Chair did not suggest that. These gentlemen are prepared to respond to any questions that you might have.

SOVIET GROUND FORCES

Mr. HERTEL. Thank you.

Does the Army stand behind the assertion that Soviet ground forces contain 53,000 main battle tanks?

Dr. SCULLEY. Yes, sir.

Mr. HERTEL. Since we signed the INF Treaty, does the Army believe the Soviet tank force is less of a threat?

General PIHL. No, sir. We think they are going to be a smaller but tougher Army.

Mr. HERTEL. You said before, you considered what they were doing modernization of their own forces. While they are doing the

draw-down, have they slowed their annual production of 3,000 tanks?

General PIHL. No, sir. Their modernization is going on.

Mr. HERTEL. Is the DOD report correct that Soviet production can surge to five times their annual production?

General PIHL. Yes, sir, in terms of the tanks as well as their design bureaus.

M-1/M-1A-1 TANKS

Mr. HERTEL. What is the total number of M-1 and M-1/A-1 we have today with 120-millimeter guns?

General PIHL. 1500.

Mr. HERTEL. The M-1 with 105-millimeter, how many are fielded today?

General PIHL. 3200-plus.

Mr. HERTEL. So, adding in the M-60 and M48A, what is the total requirement for tank today?

General PIHL. The procurement objective, sir, will be in excess of 10,000.

Mr. HERTEL. Last year, you testified before this committee that the Army 5-year plan would require 3,000 tanks of both types. This year, the Army has a 5-year plan slashing tank production and closing plants. How does current production differ from your testimony of last year?

General PIHL. It differs only in terms of affordability and the results of the deliberations of the Department of Defense in December, when we were preparing the budget. We were directed to budget to lay away a tank plant, and to produce all the tanks in the budget request at one facility.

Money was provided by the Defense Department in that budget to do that.

Mr. HERTEL. All the plans changed in December. In December, they decided all those things were not true, and those projections were not true any longer?

General PIHL. In the direction we received from the Defense Department, if you reduced it to one sentence as you just did, that is true.

Mr. HERTEL. So the Army did not make this decision?

General PIHL. The Army sent forward a budget request to build 603 tanks, 155 of those for the Marine Corps, at two plants.

Mr. HERTEL. To your knowledge, has it ever been done at this stage of a very successful program? Of course, in our briefing today, the Abrams tank is called the cornerstone of conventional defense.

In your experience, has a program that successful, that needed to be called the cornerstone of conventional defense, ever been cut so drastically as you say in the charts or been reduced to pay the R&D bill for future development? Has that ever been done before by the Army?

General PIHL. No, sir, not to my knowledge.

Mr. HERTEL. Can you say that it is responsible to do that?

General PIHL. Sir, given the arena that we are participating in now, and the reality of the budget constraints, it is certainly from

an Army perspective not the most responsible thing we have ever done, but we are down to some very tough choices.

Mr. HERTEL. There were 603 tanks requested, but the figures being talked about are 480. What is the status?

General PIHL. At this point in the various deliberations we have had in the budget revision, until we are able to transmit that budget to you, it is just a position that has been taken by the Army. The Defense Resources Board has not yet met to decide what the final outcome will be.

Mr. HERTEL. The Army is still talking about the 603?

General PIHL. At the present time, yes, sir.

Mr. HERTEL. If we went to 480, the other talk, isn't that true that would be too low to sustain the work done at Lima?

General PIHL. Yes, sir, in terms of the prices we are getting. 576 is break-even for two plants, and 516 for the other plant.

Mr. HERTEL. Mathematically, isn't it impossible to stay inside the Soviet acquisition cycle when they are building five times the number of tanks we are building?

General PIHL. Yes, sir. We would still need more tanks.

Mr. HERTEL. Can five Soviet T-80s defeat the M-1 tank at that ratio?

General PIHL. No, sir.

Mr. HERTEL. The Soviets are outproducing us 5 to 1. If we look at the closing figures given to us by the Army, we see in 1990, it would be a savings of $18.4 million. If the second plant were kept open, it would be $18.4 million in 1990, and $24.4 million in 1991. It costs more to close the plants.

General PIHL. Yes, sir. The incremental cost of producing at the plant in Detroit is less than the cost for laying the plant away, correct.

Mr. HERTEL. You would be spending more money to close the plant and build less tanks. How does that figure into your budget constraints and defense of the country?

General PIHL. Sir, we would be better off building at the plant in Detroit, but the unit cost will increase.

Mr. HERTEL. Lima and Detroit plants, too. If we close the Detroit plant, additional money must be spent to facilitate what has to be done?

General PIHL. In terms of their production throughput, you would have to increase that capacity, correct.

Mr. HERTEL. Figuring those costs that we have received estimates for the Army, it is going to cost in the budget for the next 2 years approximately $75 to $80 million to save $35 million approximately by closing the Detroit plant. It is going to cost about $50 million more to close the plant under those estimated we have looked at.

General PIHL. Based on the surface of those calculations, that would be true, sir. The anticipated savings from the layaway from the plant would not occur for 5 to 6 years. Our estimates would be that we would save $35 million a year in the out-years.

Mr. HERTEL. After losing $50 million over and above the $50 million projected savings.

General PIHL. Correct.

Mr. HERTEL. It is still a net loss; we will be breaking multi-year contracts? What is the cost?

General PIHL. I don't have them at my fingertips, but that could be a large sum, if we were not smart in the timing.

Mr. HERTEL. General, if we did close the plant and we had to restart, we understand it would take at least 13 months for the supplier and at least 6 months for the prime to restart; true?

General PIHL. Yes, sir.

Mr. HERTEL. So it would be not until 1994 if it was decided——

General PIHL. To start again? Yes.

Mr. HERTEL. Have we studied the effect on mobilization of closing the Detroit plant?

General PIHL. No, sir. That work is just starting now. Before we spend too much of the money set aside for that, to be very candid about it, we have slowed that in order to fully understand what is in the best interest of the United States Army.

Mr. HERTEL. Who made that decision? Did they take a look at that factor?

General PIHL. They did not.

Mr. HERTEL. The figures that we have looked at show that as far as mobilization studies based on the 1985 data by ORI of emergency capacities, supplies of tanks will be reduced to 50 percent of initial inventories by the end of the third month of a major conventional war, based on unclassified NATO scenarios.

Do you agree?

General PIHL. Yes, sir.

Mr. HERTEL. Those studies were based on production of both tank plants.

General PIHL. Yes, sir, and the 1,440 surge capability of full capability.

Mr. HERTEL. Where would you be today?

General PIHL. Down in the 720's.

Mr. HERTEL. You have said that the Army would be looking at 1996 for the new tank.

BLOCK III TANK

General PIHL. Sir, we would have the Block III tank in the inventory in fiscal year 1997.

Mr. HERTEL. A brand-new tank?

General PIHL. Essentially it is a tank that has components that are all new. The silhouette we have depicted on Mr. Singley's chart. Page 6 in Mr. Singley's briefing shows the capability we were looking for in the Block III tank. It has a new propulsion system, a reduced volume engine.

We are looking at an automatic loader to replace the soldier loader currently in the tank and reducing the crew from four to three, with a greater rate of fire because it would preserve the Block II capability of the commander's independent station and viewer, longer track life and a better suspension system.

The point I would like to make, because I am often asked the question is it a Block III or a new tank, it looks more like a tank. It is not an aerospace machine. We are preserving our ability to use the acquisition regulations and pursue a product improvement approach to this because that is the one way we can insure a fielding by 1997.

If we started with a blank piece of paper and turned it over to United States industry, the earliest year—following all the rules and regulations—that we could field that tank would be 3 years after the Soviet FST III arrives.

Our books are open. We are trying to insure that everyone understands that the decision reviews which the Block III tank will go through are the same as what a new start tank would go through. The concurrency has to do with the threat.

Mr. HERTEL. I understand. I understand what an excellent job the Army has done with the tank. The service has some of the finest quality ratings.

But when you talk about all of these changes to meet new requirements, how much has been done that you can talk about in open session?

General PIHL. Sir, we have integrated an advanced tank cannon on an M–1 chassis and have fired it successfully at Aberdeen Proving Ground.

The hardware we have worked that we will eventually turn over to industry so that we will be able to compete is done in propulsion, in the cannon and ammunition, in the suspension system and improved armor system.

The question is to integrate those four packages into a Block III tank.

Mr. HERTEL. If you had to point to one thing in open session that is most necessary for 1997 and beyond, what singular attribute would that be?

ADVANCED TANK CANNON

General PIHL. The cannon, clearly. The Advanced Tank Cannon, ATAC is tied to the lightweight 120mm gun. The breach weighs less. It has two-piece ammunition as opposed to one. We know it will kill the threat.

Mr. HERTEL. How much work has been done regarding using that on the M–1?

General PIHL. Sir, we already have that integrated into an M–1 chassis. It does not have the depression angle, however, that you would need to fight on the battlefield. If you wanted to integrate the large caliber gun into a current M–1, you would have to raise the roof of the turret about eight inches to integrate that system.

TANK PRODUCTION

Mr. HERTEL. If the projections of lower production of the tank are agreed to, in 1994 how many tanks will we have?

General PIHL. If we assumed the rate that you mentioned, at the time we were buying the Block II tank, cut in at 1992, to give it a rough guess by 1994 we would have just about 1,800.

Mr. HERTEL. By 1997, an estimate, if you can.

General PIHL. Another 1,200 if you continue at that rate.

Mr. HERTEL. Then if all the optimism about being able to so quickly have the Block III program in production did not work, how far behind the Soviets would we be at that point?

General PIHL. Seriously behind, sir. Obviously one of the choices is to continue to buy the M–1A–1 tank as far out as we can see.

Given the ability to service targets the Block II provides, we have looked at lesser numbers of better tanks because of the abilities.

Mr. HERTEL. If we had all the optimism in the world and all the things added to Block III went perfectly, under the time constraints we would still be just beginning production, so for the rest of the century we would be behind the Soviets further than we ever projected.

Is that true, Dr. Sculley?

Dr. SCULLEY. On the quantity issue, they don't take much out of service. Taking quantity and quality, I don't think we are any farther behind than we were in 1980.

Mr. HERTEL. If we build fewer M-1's, we wouldn't be farther behind, in your view?

Dr. SCULLEY. I didn't mean that at all. The point I was making, it is further than we have ever been behind in history. Looking at total tank posture, I don't know of a period of time that was any worse, quantity and quality included, than it was in 1980.

I share your concerns with the qualitative improvements that the Soviets have demonstrated and documented of superior production capability. The situation, despite our best efforts, does not get better.

Mr. HERTEL. Dr. Sculley, with your taking leave after all the excellent work you have done, particularly in this area and the results this committee is seeing, how does it make you feel when we are talking about changing all of the projections we had, in this December decision, to take the cornerstone of defense and move it to R&D?

R&D

Dr. SCULLEY. I applaud the accord reached in the INF treaty. But it doesn't make me feel good. It places an additional burden on the conventional land force, the superior soldier I talked about, the quality system we had—with the increased burden on that force, even in the most austere times, it needs to be resourced accordingly. I don't feel good about that.

Mr. HERTEL. Thank you for your frankness.

Mr. Chairman, I have taken too much time. I have some questions to include in the record.

Mr. DELLUMS. We will do that.

[The questions can be found at the end of the hearing.]

Mr. DELLUMS. Mr. Stump.

Mr. STUMP. I apologize for coming in late. There are too many meetings at the same time.

Mr. Chairman, I have a statement I would like to submit for the record, and also some questions.

Mr. DELLUMS. Without objection.

[The following information was received for the record:]

## PRIORITIES FOR MINE SYSTEMS

Mr Stump. General Pihl, how does the Army set its priorities for mine systems?

General Pihl. The Proponent (School Commandant) establishes initial priorities within his area of responsibility. For mine warfare, the Proponent is the Commandant of the Engineer School. These priorities are then analyzed by the Integrating Centers and Training and Doctrine Command, to insure the priorities are properly integrated with other Army priorities, to give a balanced warfighting capability. These priorities are then reviewed at Headquarters, Department of the Army as part of the Battlefield Development Plan (BDP) and the Long Range Research, Development and Acquisition Plan processes. The established priorities are;

1. VOLCANO
2. Wide Area Mine (WAM)
3. Wide Area Side Penetrating Mine (WASPM)
4. Improved fuzing for the existing conventional mines.

## MINE EMPLOYMENT

Mr Stump. General Pihl, what mines does the Army intend to employ in an urban (MOUT) environment (where top attack systems may not be practical due to buildings, IR emitting ventilators/chimneys, etc.)?

General Pihl. Engineer and maneuver units will use the existing stockpile of conventional anti-personnel and anti-tank mines.

## MINE SENSOR EMPLOYMENT

Mr Stump. General Pihl, what mix of bottom, side and top attack systems does the Army plan to employ to compound the enemies' countermeasure problems?

General Pihl. The most effective minefields are multi-dimensional: That is, they will attack the enemy from several aspects, some from a standoff distance and some from directly under the enemy's vehicles. Although a precise answer cannot be given, because it depends on the specific battlefield situation, the Engineer School has initiated a study to determine the proper generic mix. The study will be completed by March 1990.

Mr Stump. General Pihl, what mix of mine sensors (i.e., radar, acoustic, IR, seismic, magnetic, etc.) does the Army plan to employ to compound the enemies' countermeasure problems?

General Pihl. The operational plan is to integrate Wide Area Mines (WAM) with conventional and scatterable mines to create complex minefields. Sensing technologies could therefore include; pressure, tilt rod, seismic, millimeter wave, acoustic, and magnetic.

## TOP-ATTACK ANTI-ARMOR SYSTEMS AND SYSTEM LETHALITY

Mr Stump. General Pihl, with many, if not most of the newer anti-armor systems being top-attack (i.e., WAM, SFW, SADARM, etc.), how does the Army plan to guard against the obvious enemy countermeasure of reducing the vulnerability of the top of the tank (with additional armor, reactive armor, spaced armor, false tops, etc.) which would be easier to accomplish than reducing the vulnerability of the tank from all aspects?

General Pihl. New anti-armor systems are top attack because the armors are relatively thin compared to frontal and side armors. The current warheads that are being developed for top attack systems are overmatching current top armors. With the addition of countermeasures such as reactive armor and spaced armor, we believe warheads being developed can still defeat the targets. Since most top attack systems use an explosively formed penetrator (EFP) warhead, Armament Research, Development and Engineering Center (ARDEC) and Ballistic Research Laboratory (BRL) have been testing EFP warheads against reactive armors and spaced armors. It can generally be stated that the effects of these countermeasures are the added thickness of materials the EFP must perforate. Reactive armors have little or no effect on a well formed, compact, single piece EFP warhead.

Mr Stump. General Pihl, since top-attack systems have relatively smaller warheads due to size and weight constraints of the delivery platform, how does the Army plan to assure that top attack systems lethality can keep pace with improvements in enemy defensive tank armor?

General Pihl. We believe the current warheads being developed for top attack systems are overmatching current top armors. With further advancements in EFP warhead technology to achieve longer and more compact penetrators, we believe top attack systems can keep pace with improvements in top armors and still overmatch the future targets.

## ATTACKING OBSCURED TARGETS

Mr Stump. General Pihl, top-attack systems which employ IR sensors cannot be used against targets under foliage, under low cloud cover, or in fog or dense battlefield obscurants. How does the Army plan to attack these targets?

General Pihl. The statement as presented is not correct. The IR sensor will function in the environments described when used in the Wide Area Mine scenario where targets are moving and "hot". The statement is correct if targets are cold. In the latter circumstances and in the circumstance where overhead foliage cannot be penetrated, the Army will continue to use existing conventional mines.

## COST EFFECTIVENESS OF TOP ATTACK SYSTEMS

Mr Stump. General Pihl, top-attack systems require several miracles to occur in proper sequence to achieve a kill. What cost effectiveness analyses have been conducted to show that Pk of these sophisticated and expensive systems are worth the cost?

General Pihl. All complex systems require a number of events to occur in sequence in order for the system to properly function. There is substantial evidence that technologically similar systems to WAM are cost effective. In February 1985, the Army completed the Cost and Operational Effectiveness Analysis for the MLRS TGW and 8 inch SADARM. Additionally, in August 1987, the Army completed the Cost and Operational Effectiveness Analysis for SADARM. Both studies conclusively showed the cost effectiveness of SADARM using various delivery means. WAM involves similarly complex technologies, and most of the same sensors.

## TOP ATTACK/SIDE ATTACK MIX

Mr Stump. General Pihl, the unit cost of the top-attack system will probably exceed the cost of a side-attack system by a factor of 10:1 or more. Has the Army considered a high-low mix of the more expensive and sophisticated top attack systems with the less expensive and simpler side-attack systems?

General Pihl. The unit cost of the top-attack to the side-attack mine is more closely in the ratio of 3:1, not the 10:1 stated. A mix of these systems has been seriously considered and previously funded, but is not now funded due to fiscal constraints. A mix of these systems would provide the Army additional capability and added countermobility resistance since WASPM utilizes another sensor technology (i.e., radar) and another aspect (side). However, use of WASPM with WAM would be restricted to hand emplacement only since the WASPM was not designed for other modes of delivery. Further, WASPM and WAM serve somewhat different functions on the battlefield. WAM is not line of sight, but will attack from the top, with 360 degree coverage, and makes threat breaching more complex. WASPM is line of sight, does not have 360 degree coverage, but provides a standoff capability in MOUT the Army does not now possess.

## WASPM

Mr. Stump. What has happened to money for WASPM provided in FY 88--has Army upheld pledge to not reprogram $2.8 million remaining?

LTG Pihl. Army still has $2.8 million of unobligated FY 88 funds for WASPM. FY 88 legislation authorized $5.0 million and appropriated $7.5 million for completion of WASPM Full-Scale Engineering Development. Subsequently, the Army was advised that approximately $15.9M of RDTE funds in addition to the FY 88 $7.5M appropriated, would be required to complete the development of the WASPM Program. Because of affordability considerations, the Army decided to terminate the WASPM program. Using the $4.5M released in FY 88, the contractor will deliver two WASPM units for a tactical test to finalize and confirm the status of the Technical Data Package prior to records storage. The Army is unaware of a pledge not to reprogram WASPM funds. However, before the Army reprograms the remaining $2.8 million to resource high priority Army programs, letter notification will be provided to Congress.

Mr. STUMP. No one on this committee supports defense more than I do. It is obvious we don't have all the money to support the programs we have. We have to look at some of them.

You mentioned retrofitting Apache. I think this is a viable option. I have some serious concerns of what we will get in LHX, given the time frame. I will submit some questions on these and other Army R&D programs.

Thank you.

INDIVIDUAL CHEM/BIO PROTECTIVE EQUIPMENT

Mr. DELLUMS. The gentlewoman from Maryland is recognized.

Mrs. BYRON. I have somewhat become the personnel person on the R&D Subcommittee. Following along in that category, one of the things that has concerned me over the last several years is the vulnerability of our men and women that we send out to the front lines in a chemical and biological environment.

I noticed you talked about the chemical and biological warfare threat which is not only growing increasingly, I agree, but I think we are seeing a worldwide increase from the Third World nations, which in the past we have not looked at as a potential problem area.

Could you go into a little more depth of what is being done in that area, not only as far as equipment for our troops, but in the R&D field what we are doing in the medical field to address those issues?

Dr. SCULLEY. Certainly the protection for the individual soldier surpasses anything we do in terms of priority. I am not sure that our actions have always demonstrated that. I think just the picture of that soldier on the cover of our weapons systems manual attempts to emphasize the importance of that individual soldier. That is why I talked about the quality of that soldier in my opening remarks.

We only recently have tended to treat clothing and individual equipment on a systems basis. It is literally incredible what we ask these young soldiers to carry on their backs and legs into combat. A large part of that, despite our best efforts, is due to the lack of a systematic approach.

We do have a program manager for clothing and equipment who will integrate our efforts, from the uniform he wears to the helmet, to the combat weapon, to the chemical protective gear and masks.

The truth is that these activities in the past have been a bit fragmented. The protective device challenge that we face has been extremely difficult and extremely complex. I can use the protective mask in fact as an example. For so many years it was in development, unable to meet the requirements for the protection levels that we desire for the soldiers. Only in the past year have we been able to obtain quantities of the M-40 masks to make a significant difference.

It has gone through vigorous and rigorous testing and I think, despite past frustrations, we have something that works.

Mrs. BYRON. I think we have all seen and most of us have tried to operate in some capability in the existing capability in the uniform, and it is increasingly difficult. I think we are way behind the

curve in increasing the capability for our military family and at the same time many other nations are moving ahead with much more serious and potentially deadly chemical and biological capabilities.

Are we moving ahead in that arena?

Dr. SCULLEY. Yes.

Mrs. BYRON. I have not found anywhere in your budget process any R&D looking at that.

Dr. SCULLEY. I only talked about one piece of what I think is the total, and that is a protective element. I would agree that our current gear in most environments is unacceptable, yet it is the best we have been able to produce, primarily because of the elements of heat stress.

The other important pieces in this area are certainly the retaliatory capability that is necessary to provide the deterrence so that we don't need to put our soldiers under the burden of operating systems in this gear.

The other pieces are then the detection systems and the medical R&D, should it be necessary to use those antidotes that have been developed. I think Mr. Singley can elaborate more and perhaps allay some of your concerns that we have ongoing in the medical community.

Mr. SINGLEY. There are several things that are new in the budget and in the Army Tech-Based Master Plan.

First of all, this year we have resourced a program called the Soldier Integrated Protective Ensemble. As Dr. Sculley pointed out and as you pointed out, it is our attempt to pull together the component technology programs that have been conducted in the past and to integrate those into a "user friendly", if you will, integrated ensemble for the soldiers of the future.

Other things that have been developed are the XM-43 Chemical/Biological Protective mask for the Apache pilot. The IHADSS on the helmet, posed a particular challenge to the mask that we had before. That looks like a promising mask. There are several lines throughout the budget that deal with the area you are referring to. We will be glad to provide that information.

[The following information was received for the record:]

CHEMICAL AND BIOLOGICAL DEFENSE PROGRAMS

The chemical and biological defense programs of the RDTE budget request address six broad areas of interest: 1) chemical retaliatory systems ($43.7M FY 90; $38.9M FY 91); 2) Reconnaissance, detection and identification ($56.5M FY 90; $57.1M FY 91); 3) smoke and obscurants ($28.6M FY 90; $29.2M FY 91); 4) protection ($104.5M in FY 90; $104.2M FY 91); 5) decontamination ($16.9M FY 90; $15.9M FY 91) and 6) medical care ($52.2M FY 90; $52.6M FY 91). The ability to detect and therefore avoid chemical or biological contamination is our first element of soldier protection. Technology base efforts are on track to provide both individual and standoff capabilities to detect generic -- all kinds of -- chemical and biological threats. The last three of the areas listed above -- protection, decontamination and medical care -- contain elements most relevant to your question on the protection of the individual soldier from chemical and biological threats.

The research investment in protection includes efforts to improve medical protection (e.g., vaccines, prophylaxes), as well as individual and collective protection. The Soldier Integrated Protective Ensemble (SIPE) has already been mentioned as an important effort in this area. The approach will be to fabricate and design several prototypes from the most promising concept/material developments in the technology base, and then evaluate the integrated ensemble in both the laboratory and field environment. The ensemble will integrate protective clothing, handwear and footwear, integrated head protection with microclimate conditioning and respiratory protection. The budget also funds improvements in the filtering technology for collective protection of shelters and vehicles. Previous work in the medical technology base supporting chemical defense led to the introduction of a pretreatment for nerve agent poisoning which dramatically increases the survival rate for exposed individuals when pretreatment is supplemented by antidotal treatment. The FY 90-91 budget funds work on concepts for medical pretreatment against nerve agents which will add sustainability enhancements to the survivability gains already in place. However, the majority of the medical chemical defense technology base will turn toward developing concepts for medical countermeasures to other classical chemical threat agents, especially those used in the Iran-Iraq conflict (e.g, vesicants), as well as some work on emerging chemical threat agents. Research efforts in the biological defense program will emphasize the development of single vaccines which are effective against more than one threat agent.

The research effort in decontamination is focusing on fielding efficient, low corrosivity, all-agent decontaminants and decontamination systems which will reduce the manpower and logistics burden of the decontamination process. Technology efforts are focused on low corrosive microemulsions, improved sorbents and self-stripping coatings; efficiency gains are expected from catalytic and enzymatic improvements. The budget years will also mark the fielding of a safe and effective skin decontamination kit for individual soldier use, as well as for patient decontamination.

Research supporting enhanced medical treatment of chemical and biological casualties will also benefit the soldier. Definitive care of individuals exposed to biological threat agents requires a capability for rapid identification and diagnosis in biological tissues and fluids. During FY 90-91 biomedical research will continue to enhance our capability to rapidly diagnose and effectively treat biological casualties. The technology base also supports research on improvements to far forward resuscitation, casualty stabilization and medical care and evacuation techniques. Areas of emphasis include definitive care of vesicant injuries, broad spectrum anti-viral drugs, antitoxins and advanced, lightweight, life support equipment.

FY90/91 budget request contains procurement funding needed to continue production of M40/42 protective masks. M40/42 masks will replace our standard series masks for individual soldiers and combat vehicle crewmen which have been in the inventory for more than 20 years. These new masks offer greater comfort, better face-to-mask seal and a check-mounted filter canister that is much easier to change. First delivery of M40 mask will occur in April 1989 followed by a five year program to replace our inventory of currently fielded masks.

Also in our FY90/91 budget request is procurement funding necessary to begin production of M43E1 Aircrewman Protective mask. This new mask is an improved version of M43 mask now fielded to our AH64 Apache helicopter pilots. The M43E1 will be the standard mask for all crewmen. It provides better protection from chemical and biological agents and much improved optical coupling with target acquisition systems and with night vision goggles. We expect to begin fielding the M43E1 in 1992.

R&D PERSONNEL

Mrs. BYRON. Are you finding it more and more difficult to draw into that R&D field the competent, advanced technological backgrounds that are necessary to move forward in the R&D?

Mr. SINGLEY. It is difficult but then there are some encouraging signs.

Under the National Defense Science and Engineering Graduate Fellowship Program that the Congress pushed for, we recently are completing an announcement for new fellowships. We have had over 4,000 applicants; we are talking about high-quality applicants.

Mrs. BYRON. That is very encouraging.

Mr. SINGLEY. Yes. The Army only has money to fund 35 and there are approximately 150 scholarships available DOD wide.

On the downside, we have a distinct pay disadvantage within the Army vis-a-vis industry. Referencing the Federal electrical and electronics engineers pay chart, the Federal Government ranked 41 out of a possible 42 in pay for electrical engineers according to a recent survey. If you look at the salaries in private industry, we are at a distinct disadvantage—whether at the entry level or whether credit is given for experience, we are at a clear disadvantage.

Mrs. BYRON. I have seen the capability erode at the commercial labs, which do not hesitate to sweeten the funding levels and pull out some of our top people involved in many programs.

Mr. SINGLEY. Yes. But I mentioned some encouraging signs, like the fellowship program.

This year for the first time in the 10 years that the National Society of Professional Engineers has awarded a Federal Engineer of the Year Award the Army was the recipient of their award—Dr. Jain, who works for our Construction Engineering Research lab, was the recipient. So there are many topnotch people in our Technology Base program.

Mrs. BYRON. Thank you.

LANCE MISSILE

Mr. DELLUMS. Gentlemen, if we can proceed for a while, we will not need an afternoon session.

Let me call your attention to the Lance Program. The justification is that it is a replacement for the aging Lance Program and it is emphasized as the key element of the 1983 decision as regards modernization of forces.

I would like to begin at ground level and ask you to describe for the committee what this program is, describe the weapon and tell us what its requirement is. Then I would like to ask questions.

Dr. SCULLEY. Thank you, Mr. Chairman.

I would emphasize where we are and where we are not. The amount of $7.5 million was provided for concept exploration for Follow-On To LANCE. That is where we are at the moment.

I think General Pihl has carefully pointed out the important separation between development and deployment situations. I will ask him to answer your question.

General PIHL. The current Lance missile system is a 22-inch missile. It has a conventional non-nuclear range of 75 kilometers, a

range for nuclear warhead of 115 kilometers. It has an accuracy of 3.5 mils inertial guidance and entered the military in 1974.

In Follow-On To LANCE, we are looking at a system that will have a solid rocket, as opposed to liquid fuel, and inertial guidance. If our studies are completed and we go into full-scale engineering development, again separating it from deployment, we could have in-service use in the mid-1990s.

We are looking at a range that will support the Supreme Allied Commander, General Galvin, which is just inside the treaty limitation.

Mr. DELLUMS. Let's walk through that for a moment.

The rationalization for the Follow-On To LANCE is modernization, correct?

General PIHL. That is correct, sir.

Mr. DELLUMS. But we are talking about a substantially different range.

General PIHL. Yes, sir.

Mr. DELLUMS. What about lethality, will that be different?

General PIHL. Yes, sir. It will be different.

Mr. DELLUMS. If the range is substantially different, the lethality is increased and accuracy is increased, then would it not be for the lay person to interpret that this weapon would be designed to hit different targets than the present Lance, since the present one has 115 kilometers?

Would it be absurd to conclude that we are talking potentially different targets for this weapon?

General PIHL. It would be for the potential follow-on threat forces opposing the Supreme Allied Commander. It is a question of where you kill the targets, not what the targets are.

What we have tried to do is hit the second echelon divisions of the second front of the Soviets and kill them as far out as we can before they arrive at the front and compound the threat at the battle sight. The targets will be tanks, BMP's, aircraft, logistical capability deep in the rear.

The question now is only that you don't let them get in as close. You start killing them at the maximum range of the system.

Mr. DELLUMS. Your response is that you have the capacity to kill at a different range level. But is it also possible to conclude that this weapon system can hit a different set of targets than the Lance?

General PIHL. It would give the Commander more flexibility because of the kind of targets that are in the depth. Yes, it would.

Mr. DELLUMS. So in talking about modernizing weapon systems, we are talking about developing a weapon that has a far different range, has the potential to hit a different set of targets, higher lethality and greater accuracy.

What is the requirement for the weapon?

General PIHL. It is a conventional capability with a nuclear warhead that we are able to use inside the treaty limitations. The requirement is to hit their formations deep in the rear, to change their tempo, to upset their implementation of their battle plan and give the Supreme Allied Commander the potential of changing the outcome of the war.

Mr. DELLUMS. Does this replace the capability that we gave up in the INF?

General PIHL. No, sir. As compared to Pershing II and the Cruise missile system and the ranges over which they performed and the accuracy with which they performed, it is in no way a replacement for that capability.

Mr. DELLUMS. INF has a 500 kilometer limitation.

General PIHL. Yes sir.

Mr. DELLUMS. We are not talking about the "so are they" now. I am not here to be tricky. My question is straight on the table.

Are we not developing a major replacement for the capability that we gave up in INF?

General PIHL. Sir, we are in concept exploration. If the weapon matures and comes onto the battlefield, the answer to your question is yes.

Mr. DELLUMS. You have several courses to take. One is, Dr. Sculley and General Pihl, that this is in the conceptual stage. One is to proceed through conception and development, and I have been here 18 years and I don't know of any weapons systems that once they get conceived get stopped.

The workers want the jobs, the developers want the money, the politicians want the support. That is not to say the system may not have a legitimacy, but it begins to develop the constituency. It seems to me where the questions need to be raised is at the conceptual level. I think one could make an argument that deploying the weapon could be very expensive.

I remember a statement that deploying Pershing II was going to bring the Soviets to the table. Well we will not argue that, whether we could have done it by deferring deployment is hindsight and serves no useful purpose.

But we did arrive at an INF agreement. One possible way is to refine the INF agreement to limit this range of weapons. One of the important aspects of INF was to remove a class of weapons. We are now spending money at the time we need to be austere.

We are spending money when we have to define our priorities in more compassionate terms. Why not proceed down the road as opposed to spending several millions of dollars? If you get to development, I would suppose many billions of dollars would be spent to build a system we agreed to stop in INF. The question is whether or not we should be pursuing this course.

Dr. SCULLEY. I respect and understand the views of the Chairman. This is concept exploration. There has been no decision to design the precise range or precisely what form it would take. On the other hand, I feel that in our position in leading the research——

Mr. DELLUMS. If you would yield for a moment, let me add a point that you could incorporate in your response. Staff informs me that you are asking for full-scale development in the 1991 budget. So the fiscal year 1990 decision accelerates into a full scale development request. If requests are going to be raised, this is the point where it happens.

Dr. SCULLEY. That is correct and I stand corrected, Mr. Chairman. On the other hand, the complementary point I would make is the importance of any such deployment. I think the significant dif-

ference in capabilities between the Pershing and ground launched cruise missile capabilities and Follow-On To LANCE are of great significance and they are of the greatest significance in the range. I do support the development of a capability to allow the United States to bargain in strength. I think the success achieved in the INF negotiations were primarily achieved from bargaining from a position of strength.

Mr. DELLUMS. I appreciate that. One of the concerns that a number of people have, including some of our allies, is that modernization becomes a euphemism in some people's minds. I don't think we want to get in that posture at all. I want to be very cautious and careful about the steps we take.

Dr. SCULLEY. Yes, and I do support that view, although I know it places additional pressures on our fine men and women in today's Army. I support the accords reached in INF and support a continuing dialogue with the adversaries in these subject areas, but again I think the success achieved is attributed from alternatives developed.

That is why I do support this endeavor and have supported the concept of exploration in the past.

Mr. DELLUMS. Thank you.

Just one final question that I would direct to Mr. Singley: In order to leverage in some way R&D investments that the Army makes, how much joint basic research is going on among the services and with DARPA? Is there any joint research going on?

JOINT RESEARCH

Mr. SINGLEY. There is the fellowship program I mentioned earlier, which is among all three services. We have MOU's with the Department of Energy. We have a memorandum of understanding with DARPA and the Marine Corps for Armor/Anti-Armor, the Army has 11 centers of excellence, out of the Department of Defense University Research Initiative Program.

Those universities have done outstanding work. There is quite a bit of collegial exchange with the universities as a whole. There is a lot of interface with the Army, Air Force, Navy, NASA, Department of Energy, etcetera.

This is the way of the future. In the past, quite frankly, there may have been some people who felt it was too difficult to have a joint program or that it took too much time. I can tell you that we have had a number of successes and with the outlook for funding, it has become a necessity.

Mr. DELLUMS. Is there anyone in the Pentagon to your knowledge whose responsibility is to coordinate all the research development of all the services, Departments and DARPA?

Is there anyone who can tell you if you are duplicating something?

Mr. SINGLEY. Yes, sir. There is a Department of Defense science and technology technical base investment strategy executive committee, which is chaired by Dr. Millburn who will testify here at the end of the month.

It is under OSD. I sit on that committee on behalf of the Army. We have counterparts from the Air Force, Navy, DARPA and other

DOD agencies. We are trying to come up with a coordinated investment strategy so that the investment strategy of the services and the priorities of the services and Department of Defense as a whole tie together.

We have an annual technology based investment strategy review which the Office of Secretary of Defense conducts. They do a scrub, if you will, of the different services technology base programs. Down at my level——

Mr. DELLUMS. Before you go down to your level, on this executive committee on which you sit, if that committee sees two branches working on research and development which has similar requirements and mission, does that committee have the authority to say we only need one of these or why don't you people get together? It is more efficient utilization of our dollars and intellectual brain power or, come together? Or can the services simply say to you that is a nice idea, but we will do it the way we choose?

Mr. SINGLEY. We have had discussions about this. Automatic target recognition is one that comes to mind. You have a science and technology committee under the Defense Acquisition Board. Those people under the Secretary of Defense work on that committee. We have had a number of such issues that come before those people.

If the Office of Secretary of Defense finds there is a need for a coordinated program, there are procedures in our Program, Plan Budget and Execution System for building a budget or the 5-year defense plan. They, of course, let their position be known and, of course, we have sustained cuts in the past.

Mr. DELLUMS. It is interesting that the Navy's budget is in excess of 10 and you are 5.6. In categories 6.1 and 6.2 you have almost the same amount of money.

Mr. Darden raised this question, but I would like to ask again, from your perspective is that an appropriate amount of money?

The reason I ask the question is that in the specific community there is a debate emerging strongly in the country that says, A, we are not committing nearly enough of our resources to basic research; that we are not expanding our capability to operate in an environment that allows us to take risks; B, that over the years much of our R&D in the military have a great civilian spin-off effect that is now dwindling significantly; and, C, much of our effort in the military now is moving quickly from research to development because there is very little basic research going on, that the effort here is to do research designed to develop a specific weapons system to meet a specific requirement and that over the long term if you define national security not simply in military terms, but in economic terms that while we may be building smarter bombs, that in economic terms we are becoming less competitive in the world because other nations are exploring basic research better than we are.

BASIC RESEARCH

Mr. SINGLEY. I cannot address the Air Force or Navy reasons for breaking out their budget the way they do.

Mr. DELLUMS. Well, my comment was designed to compliment you. At least you break out your percentage.

Mr. SINGLEY. That has to do with the breadth of things we have to deal with. We have a plethora of different areas where we have to be on the leading edge because our products are so broad in perspective. That has to do with the 13 key emerging technologies I discussed. You will note that compared to the Navy, we have a larger 6.3A technology demonstration component.

I think we got the jump on speeding technology to the field. We have in the past had very strong pressures on reducing the basic research program because it is so often difficult to explain what the next year's pay-off is going to be from basic research.

We have stabilized the technology base. When you take a look at how we set the floor for basic research in and exploratory development which takes the products out of basic research, when you look at how the Army has the centers of excellence to augment the university research initiative, hopefully as a result of focusing our strategy and being able to articulate our case for technology, not only in 6.2 or 6.3A, but also in basic research we will be able to compete better in future research budget deliberations.

Mr. DELLUMS. Thank you very much. Dr. Singley, Dr. Sculley, General Pihl, we thank you. We have so many things going up here. We have two budgets. This is a new assignment for the Chair.

There is a certain degree of self-consciousness because there is a whole range of issues that the Chair has to grasp. I echo the sentiments of one of my colleagues that your presentation seems to be straightforward and looking from a sense of history. It appears to be a step forward.

We appreciate that. This committee, perhaps more than any other committee, has the luxury of thinking long-term and challenging policy and helping to use our resources in an efficient and effective way.

I hope over time we will learn how to talk with each other, communicate and think along with each other. There are a number of questions that the Chair, staff and colleagues would like to submit for the record.

[Additional questions for the record and the publication "Equipping the U.S. Army" follows:]

Mr. Darden. The Congress has been concerned about the adequacy of the Army's anti-armor capability. For this reason, it has supported the early development and deployment of the AAWS-M System. However, this system will not be available for several years. We can not permit those units of our forces that are most likely to see action prior to the fielding of AAWS-M to be equipped with an inadequate anti-armor system. For this reason, in the FY 89 Authorization/Appropriation Acts, the law directed that the U.S. Army select the most effective system from four alternative systems, DRAGON 2, DRAGON 3, MILAN II, AND BILL. The law did not ask the Army to procure the cheapest system, nor the most convenient to acquire, nor did it specify that selection of an interim system should be consistent with the Army's existing plan. The Act specified that the Army should procure the "most effective" system from the list of systems identified in the law.

In the report accompanying the House bill, the Committee emphasized tank-killing capability, gunner survivability, portability by field troops, countermeasures, vulnerability, system reliability and safety.

Has the Army in its report, addressed these issues and made side-by-side comparisons which can be reviewed by Congress?

General Pihl. To the best of its ability, the Army has addressed in the operational testing and evaluation the considerations listed by Congress. Both MILAN and BILL were subjected to a full range of technical and operational tests IAW the plan which DA submitted to Congress in 1987. GEN III DRAGON was not tested because the program was in development and no hardware was available. (The program has since been terminated.) DRAGON GEN II was not tested either. This is because there were no production GEN II rounds available for a technical test when the MILAN/BILL tests were run, nor were there any inert GEN II warheads to conduct an operational test. Earlier USMC tests of the round indicate that the GEN II warhead increased the armor penetration of the warhead by 85% without significantly affecting the missiles flight characteristics or probability of hit. DRAGON II comparisons against MILAN/BILL were made utilizing data available from the eight previous operational tests of DRAGON conducted between 1972 and 1978.

## INTERIM ANTITANK SYSTEM

Mr. Darden. The Department of Defense Office of Operational Test and Evaluation recently has conducted an independent assessment of the Army's decision to continue procurement of the DRAGON II. It is our understanding the DOT & E report does not conclude that the DRAGON II is the most effective of the interim system candidates. DOT & E apparently agrees that true comparative testing has not been undertaken, as called for by Congress, and will not certify the Army DRAGON II decision without true testing. Has the Army reviewed the DOT&E report, which is now available, and if so can the Army justify its preliminary decision on DRAGON II, as reported by Defense News?

General Pihl. The Army has reviewed the DOT&E report. The preliminary Army decision that GEN II should be the interim system is based on its evaluation that (1) neither BILL nor MILAN offer significant operational advantages over DRAGON II, although there obviously are individual areas, such as range, where MILAN and BILL do offer improved capabilities; (2) both MILAN and BILL have demonstrated shortcomings which offset whatever advantages they

offer in terms of operational suitability, and (3) the cost vs. expected utility of either MILAN or BILL do not make them cost effective solutions.

Mr. Darden. Does that decision meet the Congressional directive absent actual firing of Dragon 2 alongside other candidates?

General Pihl. Yes, technical testing confirmed that the warhead upgrade will have no operationally measurable impact on the soldier's use of the Dragon system other than increased penetration of the target. Operational test results from previous Dragon testing provide adequate information to complete an assessment of this system.

INTERIM ANTITANK SYSTEM

Mr. Darden. How much money has been obligated from FY 89 and prior year appropriated to procure the DRAGON II pursuant to the FY 89 statutory requirement to procure an interim system? Of the amount obligated, how much has been expended?

General Pihl. The DRAGON II obligations are as follows:

| | (MILLIONS) | |
|---|---|---|
| | FY 88 | FY 89 |
| Received | 7.258 | 17.281 |
| MIPR to USMC | 7.285 | 17.281 |
| Obligated | 7.258 | 0.226 |
| Expended | 0.068 | 0 |

Mr Darden. Were the DRAGON 2 and DRAGON 3 operationally tested in an identical manner with the BOFORS BILL and MILAN.

General Pihl. To the best of its ability, the Army has addressed in the operational testing and evaluation the considerations listed by Congress. Both MILAN and BILL were subjected to a full range of technical and operational tests IAW the plan which DA submitted to Congress in 1987. GEN III DRAGON was not tested because the program was in development and no hardware was available (the program has since been terminated). Since DRAGON GEN II was only a warhead retrofit it was not tested either. Additionally, there were no retrofit GEN II rounds available for a technical test when the MILAN/BILL tests were run, nor were there any inert GEN II warheads to conduct an operational test. Earlier USMC tests of the round indicate that the GEN II warhead increased the armor penetration of the warhead by 85%. Actual firings of Dragon II are not necessary; technical testing confirmed that the warhead upgrade will have no operationally measurable impact on the soldier's use of the Dragon system other than increased penetration of the target. DRAGON II comparisons against MILAN/BILL were made utilizing data available from the eight previous operational tests of DRAGON.

Mr. Darden. In March 1988, the US Army submitted an Anti-Armor Munitions Master Plan which included estimates of the Probability of Hit and a Probability of Target Kill for the Dragon II. In the Army's response to the provisions of the FY 89 law, were the same probability estimates used? If not, why not?

General Pihl. The March 1988 data were not used. The Army conducts an annual update of threat description. The Fall 1988 update resulted in minor changes to probability of kill for all of the systems. The adjusted estimates were used in the Army response.

INTERIM ANTITANK SYSTEM

Mr. Darden. Please rate each of the systems in order of their maximum range, time to target, and their smoke/flash signature.

General Pihl. both BILL and MILAN II have equivalent range and missile speed which are twice the range and speed of DRAGON II. Launch signature is approximately equal for all systems.

Mr. Darden. Please rate each of the candidate systems in rank order with respect to Probability of Kill given a hit for enemy targets that could be expected to be encountered within the time period prior to the fielding of AAWS-M.

LTG Pihl (S-NF) AMSAA estimates of probability of kill given a hit results in a ranking (best to worst) of Dragon II, BILL, and MILAN 2 for fully exposed moving and stationary targets out of 1000 meters. For hull-defilade targets, the ranking is BILL, Dragon II, and MILAN 2. Beyond 1000m, which exceeds Dragon's capability, BILL is better than MILAN 2. For each system, the data reveal little variation between target types (T80 and T72, with and without applique) or target motion (stationary and moving). Specific estimates for one highly probable threat that a contingency force would encounter are shown below.

| Target | Probability of Kill Given a Hit (PK/h) |
|---|---|
| <u>Exposed T72</u> | |
| Stationary (500m) | |
| Moving (500m) | |
| Stationary (1000m) | |
| Moving (1000m) | |
| <u>Hull-defilade T72</u> | |
| Stationary (500m) | |
| Stationary (1000m) | |

Mr. Darden. If Dragon is not rated the most effective by DOT&E, has the lovest Probability of kill, and results in the lovest probability of gunner survival (due to its short range, lov velocity, and large smoke/flash signature) does the Army's selection of Dragon comply with the statutory requirement to select the "most effective system?"

General Pihl. The Army evaluation of the operational test issues addresses the specific concerns raised by Congress. The language also specified that the SEC Army make his determination based on other factors, including portability by field troops, countermeasures vulnerability, system reliability and safety. A Cost and Operational Effectiveness Analysis was also required. When all of these factors are considered, the overall evaluation

supports the selection of DRAGON GEN II and does, in fact, result in the selection of the "most effective system".

Mr. Darden. Is the Probability of Kill for the Dragon the highest among the candidates?

General Pihl. Yes, under most circumstances within its range capability.

Mr. Darden. Did the figures you used for Probability of Hit and Probability of Kill for the Dragon in the study to determine the most effective system match those you submitted to Congress in the DOD Anti-Armor Munitions Master Plan of 3/88?

General Pihl. The March 1988 data were not used. The Army conducts an annual update of threat description. The Fall 1988 update resulted in minor changes to probability of kill for all of the systems. The adjusted estimates were used in the Army response. These adjustments did not change the conclusions.

Mr. Darden. What is the range of the Dragon?

General Pihl. Approximately 1000 meters.

Mr. Darden. What is the range of the BILL?

General Pihl. Approximately 2000 meters.

Mr. Darden. What is the range of the MILAN?

General Pihl. Approximately 1950 meters.

Mr. Darden. Which missile is fastest?

General Pihl. BILL and MILAN are essentially equal and are about twice as fast as Dragon.

Mr. Darden. Would you characterize the Dragon as a slow missile?

General Pihl. Yes.

Mr. Darden. Don't range and speed of the missile combine to give you a measure of gunner survivability?

General Pihl. Range and speed are two elements that impact gunner survivability. Others include system detectability, system exposure, time to move the system to cover from an exposed firing position, and susceptibility to countermeasures. Additionally, the survivability of the force comes into question if a system cannot be employed on a drop zone during the highest period of risk or arrive at a critical point in battle from an extended approach march due to problems with transportability and portability. These type of employment problems are what makes MILAN and Bill unacceptable as an interim anti tank system for the contingency forces.

Mr. Darden. Are either of these two systems (BILL or MILAN) top-attack?

General Pihl. MILAN is not a top attack weapon. BILL does attack from the top in its primary employment mode. However, based on the technical warhead and flight tests, BILL does not provide significantly increased lethality over DRAGON or MILAN for two reasons: BILL has a relatively small unitary warhead which is canted to shoot down at a 30 degree angle into the top of a target.

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Mr. Darden. If the DOT&E assessment is at odds with the Army position, would you be willing to have a side-by-side live fire shootoff of each of the systems in order to give everyone the

opportunity to witness how Dragon performs against each of the other systems, with DOT&E providing fair test parameters?

General Pihl. Side-by-side live fire testing under parameters agreed to by both the Army and DOT&E could provide additional comparative data. However, such testing is not necessary to support a Supplemental Interim Anti Tank System (SIMATS) decision.

## ARMY RESEARCH AND DEVELOPMENT

Mr. Weldon. You have indicated that LHX is the centerpiece of the Army's aviation modernization, and your strong support for the program. As the Administration reworks the Reagan Budget, will this support continue? Is there any possibility of LHX program reductions under the Bush revisions?

General Pihl: The LHX is still the Army's number one R&D program and as such, has the continued support of the Army's leadership. Every effort will be made to maintain full funding for this program.

## HEAT SHRINKABLE FILM FOR HELICOPTER TRANSPORTATION

Mr. Weldon. Did the Army ever do independent research of its own on this process and do we have documentation?

General Pihl. The Army's experience in wrapping helicopters with heat shrinkable film goes back to 1986. In August 1986 Aviation Systems Command (AVSCOM) contracted with Film Applicators of North America (FANA) to support an Army effort to wrap two AH-64 Apache helicopters and auxillary equipment for sea vessel shipment to Europe. Written procedures for the process did not exist at that time. In February 1987, AVSCOM contracted with Tri-State Packaging Supply Corp., to support a similar effort to wrap two CH-47B Chinook helicopters. In May 1987, AVSCOM contracted with FANA to support an Army demonstration of shrink film wrapping techniques to be given to Army personnel at Fort Eustis, Virginia. Subsequently, AVSCOM Distribution and Transportation Division formalized shrink wrap procedures for all Army helicopters. Procedures have been published in shipping manuals for each helicopter system.

Mr. Weldon. Who are the individuals responsible for the research and when was it done?

General Pihl. The Chief of AVSCOM's Distribution and Transportation Division, Directorate for Materiel Management, during the period of August 1986 through May 1987 was Mr. Don Johnson, GM-15. The Distribution and Transporation Division had general overall responsibility for research and development activities in this area.

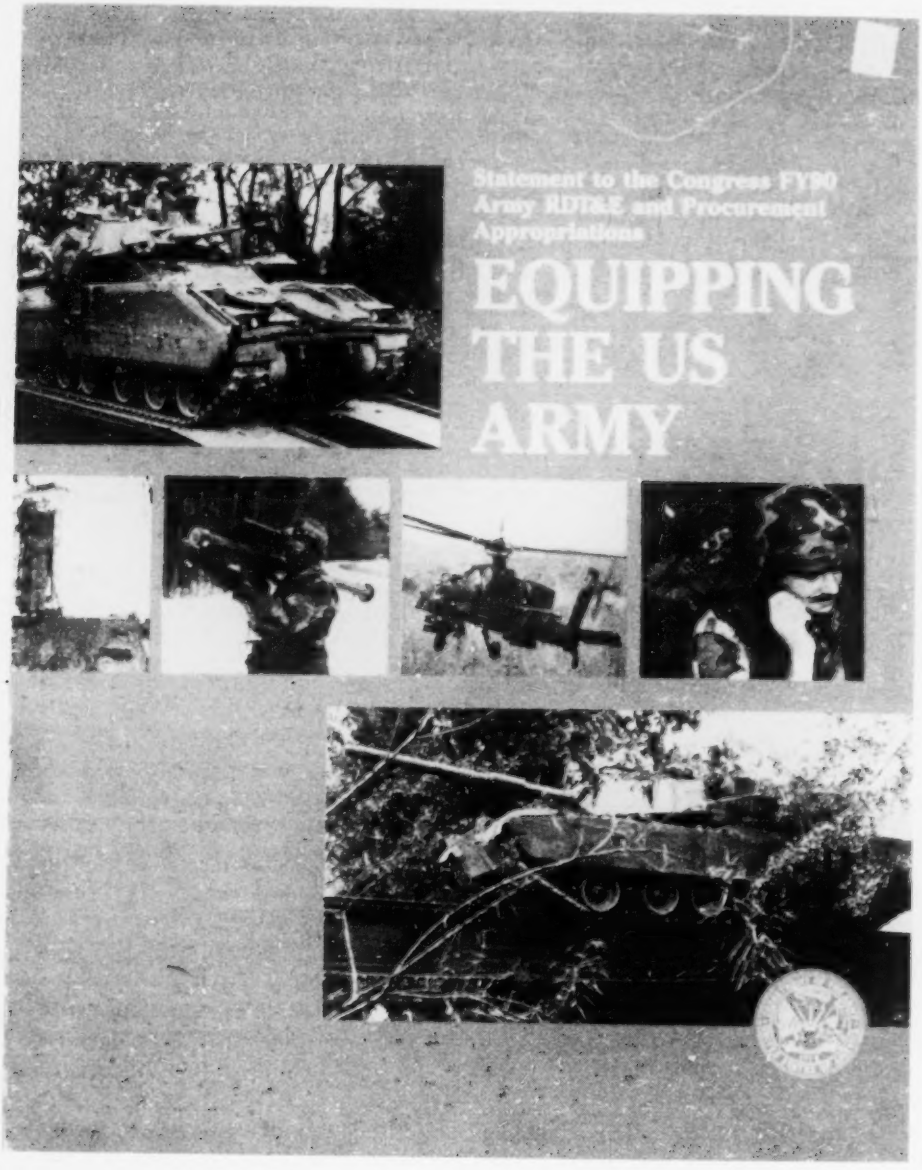
COMMENTS: It should be noted that attorneys for Film Applicators of North America (FANA) contacted the U.S. Army Aviation Systems Command (AVSCOM) Legal Office in February 1989, with questions about the Army's process for wrapping helicopters. These questions were addressed by AVSCOM lawyers in a written response. In the response, AVSCOM asked some questions of FANA attorneys and are currently awaiting their reply.

## INTERIM ANTITANK SYSTEM

Mr. Pickett. According to Defense News of Feb 27, 1989, the Army has decided to pick Dragon II as the interim antitank weapon to be used until a new system is deployed in the mid-1990s. The Defense News article implies that Dragon II and some of the other competing systems cannot defeat reactive armor. We know that the Soviets have reactive armor on their tanks. What kind of test did the Army do on Dragon II against reactive Armor? Is the Army prepared to show that the Dragon II can defeat reactive armor?

General Pihl. The Army tested the Dragon II warhead against reactive armor. The Dragon II warhead did as well as, if not better than, the MILAN and BILL against the same targets.

[illegible] we are developing AAWS-M. The Army has looked across the board in determining its requirements for an interim system. The first fielding priority for an interim system, just as for AAWS-M, is to high priority contingency forces. Given the anticipated threat that contingency forces could expect to encounter and the time frame involved, Dragon II provides an acceptable interim capability.


Statement to the Congress FY90
Army RDT&E and Procurement
Appropriations
EQUIPPING
THE US
ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

February 28, 1989

Members of Congress:

To win on any battlefield across the spectrum of conflict we need quality soldiers who are well trained, well led, and well equipped. With the support of Congress, the Army has made that winning combination a reality in the 1980's. Our warfighting capability has improved steadily, with an improved equipment posture contributing significantly to that goal. Our ground forces are becoming a well earned and meaningful symbol of our nation's resolve to maintain an adequate deterrence to war.

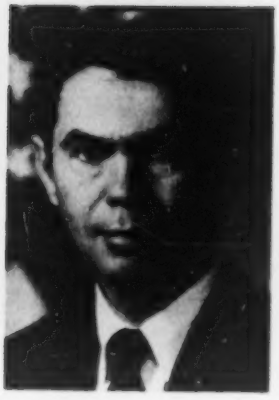
Maintaining our momentum in Research, Development and Acquisition, in a time of fiscal constraints, is a challenge that requires vigilant and innovative RDA management. We continue to streamline the acquisition management process in accordance with Presidential and Congressional mandate. Our reorganization has resulted in a shortened and direct reporting chain allowing for better, more concentrated management. Cost effectiveness is a concern at every stage of the RDA process. The maximum use of competition, multi-year procurement, and other cost saving methods are critical. To provide further cost discipline, within an operationally meaningful framework, we are developing a cohesive set of mission area modernization plans. The recently completed Army Aviation Modernization Plan will serve as a model for plans to follow. With adequate economic stability, we can plan more effectively for the near, mid and long term; however, undue turbulence in the levels of funding complicates efforts to insert rational cost control into the RDA process.

In our enclosed statement we try to provide a context for individual program requests. Following the introduction, which provides an overview of RDA objectives, weapon system programs are covered under AirLand Battle Doctrine categories so that strengths and weaknesses can be measured against operational needs. In addition to this statement, we are making available to you the 1989 Army Weapons Systems Handbook, a consolidated reference for a number of our weapons systems.

It is an honor to represent the Army before the first session of the 101st Congress. We trust our testimony contributes to your deliberations.

Donald S. Pihl
Lieutenant General, GS
Military Deputy to the
Assistant Secretary of the
Army (Research, Development
and Acquisition)

J. R. Sculley
Assistant Secretary of the Army
(Research, Development and Acquisition)



## Honorable Jay R. Sculley

### Assistant Secretary of the Army for Research, Development and Acquisition

Dr. Jay R. Sculley, the Assistant Secretary of the Army for Research, Development and Acquisition, took office on October 13, 1981.

As Assistant Secretary of the Army for Research, Development and Acquisition, Dr. Sculley is the Scientific Advisor to the Secretary of the Army and is responsible for Army-wide policy development and oversight of research, development, test and evaluation programs for materiel acquisition management, policies and procedures. He is also responsible for implementation of worldwide security assistance policies and international programs.

Dr. Sculley is a graduate of the Virginia Military Institute where he received a Bachelor of Science degree in Civil Engineering in 1962. Following graduation from VMI, he served as an officer in the U.S. Air Force and later was a design engineer with the Dupont Company before earning his MSE and Ph.D. at the Johns Hopkins University.

In 1970, Dr. Sculley joined the VMI faculty and served four years as an assistant professor of civil engineering before electing in 1974 to leave teaching and enter industry. He was General Manager of Corrugated Services, Inc., a Texas paper recycling company, for one year before returning to VMI in 1975.

During his faculty years at VMI, he was actively involved in engineering research through the VMI Research Laboratories, Inc. He is the author of numerous papers and has been elected to Who's Who in Engineering. At the time of his appointment by President Reagan, he was Professor and Head of Civil Engineering, VMI's largest academic department.

Since assuming his present position, Dr. Sculley has been instrumental in improving the management and cost discipline of major hardware acquisition programs. He directed the integration of technology base efforts throughout the Army and expanded the program for centers of excellence at American universities for Army sponsored research. He has also initiated programs to upgrade the training, development and utilization of people throughout the research, development and acquisition field.

Dr. Sculley is married to the former Peggy Lee Winkel of Baltimore. They have a daughter, Rebecca Lee and a son, Mathew Jay.

## Lieutenant General Donald S. Pihl

**Military Deputy to the**
**Assistant Secretary of the Army**
**(Research, Development and Acquisition)**

Lieutenant General Don Pihl was born in San Francisco, California, on 18 August 1937. He was commissioned a second lieutenant in Armor through the Reserve Officer Training Corps Program upon graduation from the University of California at Berkeley in 1959. He earned a Bachelor of Science degree in Business Administration and later a Masters in Business Administration. His military schooling includes the Armor Officer Basic Course at Fort Knox, Kentucky, the Quartermaster Career Course at Ft Lee, Virginia, the Armed Forces Staff College at Norfolk, Virginia and the Army War College at Carlisle Barracks, Pennsylvania.

General Pihl held various troop and squadron positions with the 25th Infantry Division, United States Army, Pacific, after which he was assigned to Korea and commanded a company in Eight Army. On returning to the United States, he was assigned to the Combat Developments Experimentation Command at Fort Ord, California, as a Contracting Officer. General Pihl served as the Aide-de-Camp to the Commanding General, United States Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland. General Pihl was assigned as S1 (Personnel) in the 16th Armor Group at Fort Knox, Kentucky. This was followed by a tour as Executive Officer, 4th Battalion, 37th Armor at Fort Knox, Kentucky. He was assigned as Executive Officer, 1st Battalion, 77th Armor at Fort Carson, Colorado and for a year with the same unit in Vietnam. General Pihl was assigned as an Operations Research Analyst in the Office of the Assistant Vice Chief of Staff, Department of the Army, Washington, D.C. He was the Military Assistant to Secretaries of the Army Resor and Froehlke. General Pihl commanded the 3d Squadron, 11th Armored Cavalry Regiment, United States Army, Europe. He was assigned to the Training and Doctrine Command, Division Restructuring Study Group and later as the Chairman of the Combat Developments Planning Group at Fort Monroe, Virginia. General Pihl commanded the 3d Brigade, 3d Armored Division (Spearhead) at Friedberg, West Germany. Remaining in Europe, he served as the Chief of Staff, 3d Armored Division (Spearhead) in Frankfurt. General Pihl became the Deputy Director of Weapons Systems, and later was reassigned as Director of Combat Support Systems in the Office of the Deputy Chief of Staff for Research, Development and Acquisition, Headquarters, Department of the Army, Washington, D.C. Prior to assuming his present position, General Pihl was the Commanding General of the 9th Infantry Division (Motorized), Fort Lewis, Washington.

General Pihl's decorations include the Distinguished Service Medal, the Legion of Merit (with Oak Leaf Cluster), the Bronze Star Medal for valor (with Oak Leaf Cluster), the Purple Heart, the Meritorious Service Medal, the Army Commendation Medal (with two Oak Leaf Clusters), and the Combat Infantryman Badge.

He is married to the former Sandra Young. They have two sons, Douglas and Gregory, and one daughter, Victoria.

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# INTRODUCTION

It is a pleasure to appear before this committee once again to describe how the Army proposes to equip and arm itself. Today, we are presenting you with an FY90 research, development and acquisition budget request for $20.5 billion. This request represents our best effort to provide a balanced program to maintain near term readiness, continue momentum in our modernization programs, and to focus on research and development efforts that promise the greatest potential for improving our warfighting capability.

The Army has made steady progress in its equipment posture in the 1980's, and our overriding concern is to maintain that progress as we look forward to the challenges of the 1990's. The need to keep our conventional forces strong has been further amplified by the recent signing of the Intermediate Nuclear Forces (INF) Treaty. Although the INF Treaty is a welcomed action, it poses an additional challenge to the Army to enhance its conventional capabilities.

The qualitative leverage we possess in some equipment areas must offset Warsaw Pact quantitative superiority and steady Soviet technological advances. Fortunately, we are able to build on the achievements of the 1980's, as the following summary will indicate.

## Return on 1980's Investment

Our procurement priority in this decade has been to produce and field a host of major items which had successfully completed R&D at the beginning of the 1980's. It would have been a national tragedy had we not been able to draw on this investment and equip our soldiers with the full range of these systems. With the support of Congress we have been able to do just that. We have established the momentum and the RDA strategy we want to continue to pursue: that is, produce new systems that have significant growth potential; product improve them to correspond to new threats and technological breakthroughs; buy Nondevelopmental Items commercially where that makes sense; and selectively invest in bringing high leverage new starts from R&D to production. Our overall acquisition strategy has been to buy equipment in a synchronized way across all mission areas.

Following this approach in the 1980's, the Army has fielded meaningful quantities of the best tank and fighting vehicles in the world (66 Abrams tank battalions and 33 battalions of Bradley Fighting Vehicles). We now have two unparalleled helicopters deployed, one devastating against armor (11 attack battalions of Apache), and the other a key asset to improved mobility and logistics, the Black Hawk Utility helicopter (over 1000 now produced). PATRIOT, the most sophisticated and effective air defense missile system ever built, is now operational in nine battalions. We have given the artillery its first rocket launcher capability in 30 years (24 batteries of MLRS fielded worldwide). Copperhead, which represents the beginning of smart munitions and an artillery capability for pinpoint destruction of high value targets, has now completed procurement (over 24,000 produced or on-contract). These are just a few of the major items that have come through the production pipeline to increase our combat power.

At the same time we have product improved a host of items to stretch their capabilities to the maximum (e.g., Chaparral, Hawk and TOW missiles, AH-1S Cobra and CH-47D helicopters, M109 howitzers, Stinger missile and many other items).

Our RDA investment efforts of the 1980s have resulted in an Army better equipped to combat the threat across the entire spectrum of conflict, however, the Soviets have also made steady improvements. A brief assessment of some Soviet equipment trends follows.

**The Threat**

For years, the West has relied upon its technological provess to manage the military threat posed by numerically superior forces of the Warsaw Pact. Since the late 1970's, however, the Pact's quantitative advantage has been complemented by qualitative force enhancements.

Research and development by the Soviets is paying off with technological advances which rival, and possibly even surpass our own. This is particularly true for ground force weapons systems where R&D accounts for a significantly greater share of defense resources in the Soviet Union than it does in the US. Examples of high-technology ground force equipment currently include a new tank, a new tactical air defense gun system, new tactical advanced helicopter gunships like the HAVOC and HOKUM, and dual-capable (conventional and nuclear), self-propelled artillery.

While the current direction of internal Soviet political debate over the allocation of defense resources is likely to result in lower military procurement levels in the next 2-5 years, perhaps sooner, there is no historical precedent nor evidence to suggest defense R&D in the USSR will suffer. The use of space-based systems to enhance ground combat capabilities will also provide better warning, command and control, and synchronization of ground force actions.

Difficult as the Soviet challenge may be, however, the Army cannot concentrate exclusively on the Soviet threat. Every reasonable forecast envisions continued instability and conflict in the Third World. Opposition forces will have at least a few weapons systems comparable to or better than our own. In some cases, they already possess a full range of modern, sophisticated weapons which are available from the world arms markets or from sponsors such as the Soviet Union.

The Chemical/Biological Warfare threat is worldwide, growing and changing in character. The Soviet Union continues to take advantage of emerging technologies in the fields of biotechnology and genetic engineering to develop new agents. These new agents result in the potential for technological surprise that poses unique challenges to our defensive capabilities. As with the conventional threat, we cannot focus just on the Soviet capability. The proliferation of chemical capability throughout the world has grown at an alarming rate. Third World countries view chemicals as a cheap and effective weapon, as was seen in the Iran/Iraq War. Forces deployed to Third World contingencies now face great risk.

The Army must continue to vigorously pursue R&D efforts in order to meet future threats. We cannot again neglect the future of R&D, as we did during the

Vietnam era, and expect to regain superiority quickly. The rate of technological change today is increasing exponentially. To provide a framework for our future modernization we are developing comprehensive plans, as outlined below.

**Modernization Plans**

Modernization is a continuous, dynamic process, that must be guided by a cohesive set of plans. The Army Aviation Modernization Plan (AAMP) has been completed. Soon to follow are Armor/Anti-Armor (A3), Heavy Force, fire support, air defense, truck, command and control, and technology base modernization plans. The Army Technology Base Master Plan, covered in the Tech Base section, is an essential component of our other master plans.

The AAMP is being used as a model in developing plans for the other mission areas. The AAMP looks 30 years out and provides a framework for modernizing aviation to correspond to advances in the threat, refinements in force design and warfighting requirements. The size of the overall fleet will be reduced from 8,600 helicopters today to a smaller, more capable force of about 6,600 helicopters by the end of FY94. Through the AAMP there are planned increases in production of Apache (675 to 975), Black Hawk (1107 to 2253), AHIP (135 to 375), and CH-47D modifications (436 to 472); Special Operations Aircraft will be built; safety and mission essential modifications will continue, and aging helicopters retired. The LHX, our light helicopter family of the future, is being developed with RDTE fully funded through the Five Year Defense Plan.

The AAMP encompasses the entire RDTE and Procurement aviation mission area to include all aircraft, their associated systems and repair parts. Systems will be procured at their most economic rate within AAMP funding and, where possible, through multiyear contracting. Through this integrated plan, short term solutions are avoided. Army aviation will enter the 21st century as a fully modernized combat effective force which will contribute unprecedented warfighting capabilities to the combined arms team. We want to use this comprehensive approach in all our mission areas.

Operationally, our RDA planning is guided by AirLand Battle requirements.

**AirLand Battle Doctrine**

AirLand Battle Doctrine seeks to exploit the full potential of US and allied forces by synchronizing all available combat means to attain that end. Modern weapons have increased the lethality of combat to the point where the outcome of engagements between large mobile forces can be determined in minutes. History has confirmed repeatedly that a relatively small but potent force striking the enemy unexpectedly can destroy a larger force. Combat power must be rapidly concentrated in tactical engagements while simultaneously degrading the operational tempo of the enemy.

To ensure unity of effort, all three areas of engagement (deep, close, and rear) are considered interrelated parts of one battle. Deep operations shape the conditions in which future close operations will be conducted. Many of our key programs are designed to keep the adversary from bringing to bear their primary advantage of mass. Rear operations assure freedom of maneuver, continuity of operations, and uninterrupted service support. The measure of

success of the deep and rear operations is the eventual impact on close operations. Close operations bear the ultimate burden of victory or defeat. The key elements which tie the total effort together and allow the combat commander to control his maneuver elements are his command, control, and communications equipment.

Weapon system programs are covered in the following pages under the deep, close and rear AirLand Battle categories to better emphasize their roles on the Combined Arms team. The combat value of our systems must be measured by their combined power which makes the sum of the parts greater than the individual contributions of the components. Conversely, our weaknesses can be seen in their true urgency in mission area context. For example, our Army now has the world's best tank and infantry fighting vehicle for mechanized warfare; however, they are currently being defended from the air threat by a 1968 vintage air defense gun. With the fielding of the Forward Area Air Defense System (FAADS), our ground forces will be defended from that air threat by the world's best air defense system. These are the kinds of weak or strong links which make or break armies.

**RDA Guiding Principles**

In developing the systems to support our doctrine we adhere to several principles to guide our efforts.

**RDA Management**

The Army has fully embraced the streamlining of the acquisition process from tailoring each system to fully complying with the Packard Commission recommendations and the derivative National Security Decision Directive 219. Our reorganization has resulted in a shortened and direct reporting chain for major defense acquisition systems. The three tier reporting chain for program management consists of an Army Acquisition Executive (AAE), Program Executive Officers (PEO's), and Project/Product Managers (PM's). This three tier reporting chain eliminates intermediate headquarters from the decision process and provides PM's with great flexibility to perform day-to-day activities on assigned programs.

The current PEO organization has been further streamlined to 14 PEOs and 1 direct reporting PM. In the original reorganization implementation there were 22 PEO and 3 independent PMs. The new structure consolidates PMs to allow better span of control and redistribution of assets within the acquisition community. The Army has incorporated the latest policy changes in the revised Army Regulation 70-1 (Systems Acquisition Policies and Procedures).

Streamlining the decision making process is allowing for better, more concentrated management of programs which will result in lower costs and more coherent, stable acquisition programs in the future.

**Total Quality Management**

Total Quality Management (TQM) is a key management initiative organized toward continuous process improvement activities in a totally integrated effort toward improving performance at every level. The TQM approach is to manage the processes which govern the quality and availability of goods and services rather

than the more traditional approach of inspecting quality into the product. TQM capitalizes on such value added strategies and techniques as Acquisition Streamlining, Could Cost, Productivity and Reliability, Availability and Maintainability programs. Every individual's contribution is actively sought to upgrade quality. Organizations which practice TQM are characterized by quality trained and motivated employees working in an environment where managers encourage creativity, initiative and trust, not large quality staffs! Our goal is to increase quality and productivity by making the TQM management approach an integral part of every functional activity in the Army - at all levels, in every organization, government and industry. TQM implementation promises long term productivity and quality improvement and better support to the soldier in the field.

**Acquisition Management Mission Cluster Group**

DOD has defined acquisition as the conceptualization, initiation, design development, test, contracting, production, deployment and logistics support of weapons and other systems, supplies or services to satisfy Army needs intended for use and/or support of DOD missions. Efficient management of the acquisition process requires well-trained, broad-based and multidisciplined managers. To fill this need the Army Acquisition Executive developed the "Acquisition Management Mission Cluster Group." This Group will provide joint military and civilian oversight for the development, training and retention of the Selected Acquisition Managers who will support the Program Executive Officers, Program Management organizations and select participants from Matrix Support Commands. The Group responsibilities include acquisition career development policy, definition of training methods, career progression patterns, career tracking and inventory, and training funding to establish and maintain a broad-based, healthy inventory of capable military and civilian acquisition managers ready to serve at all levels of management.

**Multiyear Procurement (MYP)**

MYP enhances program stability, encourages economic production rates, and saves money. The Army strongly supports multiyear contracting while recognizing it is not suited to every materiel acquisition. The Army will continue to evaluate each potential MYP candidate, balancing advantages against constraints individually, and supporting multiyear acquisition strategy whenever possible. For FY90-91, the Army will submit the following MYP candidates for Congressional approval: Bradley Fighting Vehicle System, Stinger (RMP), Stinger (Pedestal Mounted), Palletized Loading System (PLS), Family of Medium Tactical Vehicles (FMTV), High Mobility Multipurpose Wheeled Vehicle (HMMWV), PATRIOT, Abrams tank and the AH-64 Apache.

**Competition**

We are also committed to competition. All major systems and components currently in development are reviewed early on in the acquisition process to minimize inhibiting factors and enable consideration of all reasonable competitive alternatives. The Army's Competition Advocate serves as the Army's spokesman for competition and maintains an active liaison with Congress, industry, the media and DoD/Army Competition Advocates. The Army exceeded its FY88 competition goal of 60 percent by awarding 61.6 percent of 33.8 billion available dollars competitively. Total procurement dollars awarded

competitively were 18.5 billion out of a total 29.9 billion available for competition. Additionally, 93.2 percent of the contract actions were awarded competitively. Other significant achievements included a decrease in quality deficiency reports for the third year. This trend indicates that quality is not being sacrificed for increased competition.

**MANPRINT**

The individual soldier comes first in all our RDA efforts. To that end we have instituted MANPRINT, the manpower and personnel integration program. MANPRINT focuses attention on manpower, personnel, training, safety, health hazard, and human factor engineering considerations during system design development, production and product improvement. The result is optimized performance of both the equipment and the soldier as integral parts of the system. Ultimately, this will reduce the demand for skilled manpower as well as the operations and support (O&S) costs associated with new or improved materiel. Using computer models which simulate both the human figure and the equipment, the total system design can be greatly refined even before prototypes are built.

MANPRINT results in positive innovations. For example, the T800 engine was developed for the LHX such that no special skills or tools are required to maintain it. Further, less than 10 tools are required by the user. Another example is the Howitzer Improvement Program where MANPRINT analysis led to reducing the crew from 5 to 4, and changes to the automatic fire control system that made it easier to use.

To sum up we are making a diligent effort to manage our RDA programs in a balanced, affordable way to equip our soldiers with the quality equipment they need to prevail in case of war. This is a definite challenge in a period of declining fiscal resources, but with your continued support the Army's RDA posture will remain, in fact, a credible element of national and international deterrence.

# CLOSE OPERATIONS

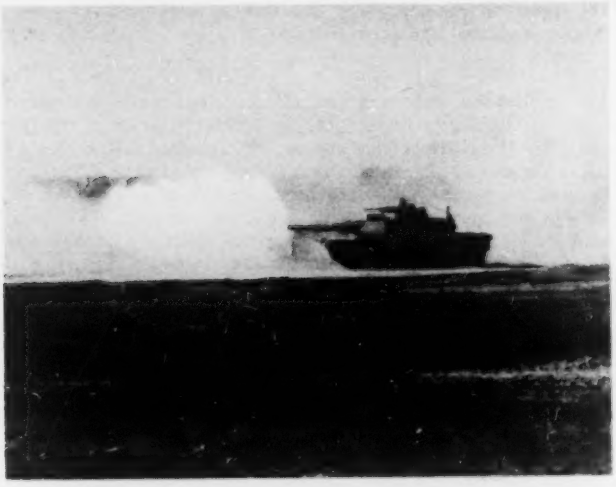
Close operations are engagements fought by infantry, armor, aviation, engineer, and field artillery soldiers and other supporting arms at the Forward Line of Troops (FLOT). These are the front line soldiers, and their job is to close with and destroy the enemy by the direct application of combat power. To accomplish their mission, they must be organized into units that are well trained, well led, and that have modern equipment to give them the qualitative edge necessary to fight and win.

The predominant weapons systems of the close battle are the tank, the infantry fighting vehicle, and the attack helicopter. Our forces equipped with these direct fire weapons and organized into combined arms teams are the nucleus of all our modern heavy divisions. The process of modernizing these systems must continue. Yesterday's "high end" of the high/low mix will soon be the low end as a result of changing threats and technological improvements. The following paragraphs will describe the key close battle systems requested in the FY90 budget.

The Abrams tank is the cornerstone of our conventional defense and armor modernization. Delivery of the basic M1 tank was completed in June 1986 and feedback from tactical commanders and troops in the field has been highly positive. The M1 has performed superbly in NATO REFORGER exercises and gunnery competition.

*Abrams Tank - Cornerstone of Conventional Defense*

The Army continues to improve the Abrams tank fleet to maintain qualitative superiority and address the quantitative superiority of the Warsaw Pact. In 1985 production began of Abrams Block I (M1A1), equipped with the 120mm cannon (versus 105MM for the basic M1), armor enhancements, and an NBC overpressure and micro-climate cooling system. These tanks will continue in production through the FY91 procurement. Although the M1 is being replaced in Europe by the M1A1 Abrams, the M1 is a highly effective combat system and continues to be fielded to active and Reserve Component units in the US and Korea.



*Abrams - Fire Power*

In FY90, the Army will procure 448 M1A1 tanks and begin the acquisition of long-lead materiel required to produce Block II (M1A2) configured Abrams in FY91. Block II will add enhanced survivability features as well as operational improvements to the vehicle (candidate improvements include a distributed data and power architecture, the Commander's Independent Thermal Viewer, Improved Commander's Weapon Station, Carbon Dioxide Laser Range Finder, and Position/Navigation equipment) to make it a more formidable opponent against the threat envisioned for the mid-1990's and beyond.

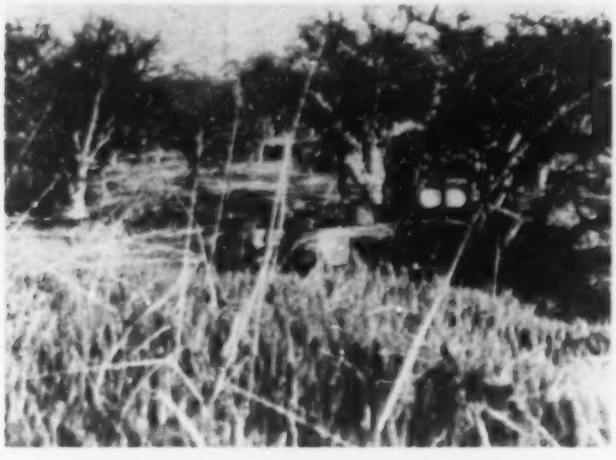
The RDTE effort in both FY90 and FY91 will begin to orient on the introduction of Block III for production beginning in FY96. This tank will include a more lethal main armament system, improved drive train and suspension, and improved modular armors that will make it the most effective tank on the battlefield into the 21st Century. Envisioned to be competitively developed and procured, Block III will be the foundation upon which the Army's next generation of heavy combat vehicles will be built.

*Abrams - Cross Country Mobility*

FY90 will be the second year of joint Army-USMC procurement of M1A1 tanks. The USMC FY90 procurement is for 155 M1A1 tanks. Egypt will begin co-production of M1A1 tanks effective with the FY90 funded delivery period.

*Bradley Firing TOW*

Bradley Fighting Vehicles (BFV) provide the mechanized infantry with a full track, lightly armored fighting vehicle, and scout and armored cavalry units a vehicle for their screening, reconnaissance, and security missions. The BFV can maneuver and fight during day or night, providing accurate fire while on the move. It has the cross country mobility to operate in tandem with the Abrams tank. The BFV is equipped with the 25MM cannon, 7.62MM coaxial machine-guns, and TOW anti-tank missiles. The more lethal TOW 2 missile has been incorporated into Bradleys fielded since 1987.



*Bradley Behind Cover*

As of December 1988, 33 battalion size units have fielded the BFV, of which four are Army National Guard battalions. The FY90 procurement provides for 600 vehicles. BFVs procured in FY90 are the survivability enhanced M2/M3A2 versions, containing improved armor, spall liners in the troop compartment and limited fuel and ammunition restowage. These enhancements will provide our soldiers with the most advanced fighting vehicle in the world. RDTE efforts in FY90 continue ammunition restowage/compartmentation and 25mm ammunition development.

*Bradley With Reactive Armor*

Since the start of WWII there has been an evolving competition to gain advantage in the tank-antitank equation. The main offensive weapon of both the US and Soviet ground armies will be the modern tank with its matching infantry fighting vehicles. The antitank systems opposing that force are equally important. Advances in technology have caused the tank-antitank equation to broaden into what we call Armor/Anti-Armor (A3), because what is changing now is not so much the thickness of the steel and the caliber of the gun but the form and composition of the tank itself. Applications of composites, laminates, ceramics and metallurgic techniques have signaled a change in the nature of the tank. Technologies of antitank weapons must also change. Today A3 must address "armor" both as a technology and a tactical concept, and Anti-Armor, which includes everything designed to defeat armor including artillery, ground combat vehicles, mine warfare, army aviation and close air support, coupled with recently developed target acquisition technology.

*Armor/Anti-Armor Modernization Plan*

The Armor/Anti-Armor Special Task Force (A3 STF) was chartered by the Chief of Staff to develop an Armor/Anti-Armor Modernization Plan for the Army. That plan will provide for adequate growth in the Army's Armor/Anti-Armor capability when compared to expected Soviet improvements in the mid- and far-term. The plan provides for a combined arms Armor/Anti-Armor capability for both the heavy and light forces, and is supportive of both AirLand Battle Doctrine and AirLand Battle-Future operational concept. Material programs, training strategies and supporting analyses are incorporated in the modernization plan. The provisions of the plan are reflected in the Army's FY90/91 Budget Submission and associated FY90-94 Five Year Defense Plan.

*Heavy Force Modernization Plan*

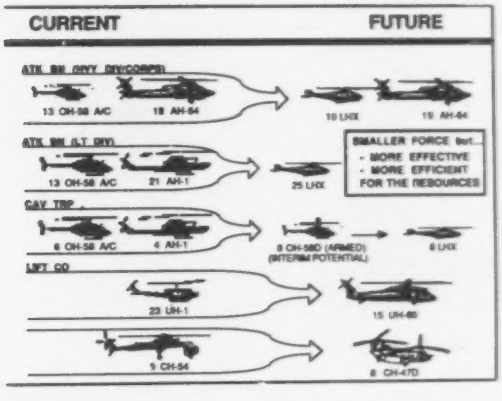
The HFMP concept envisions the heavy combined arms force and its support systems being designed and developed for maximum warfighting capability within resource constraints. Periodic improvements are planned from the outset to ensure timely incorporation of both

evolutionary and revolutionary technologies. Developing, producing and fielding future weapons systems on a common chassis with compatible survivability and mobility are central to this plan. Execution of this strategy requires an expeditious approach, maximizing industry involvement and competitive opportunities.

The initial package of variants will consist of the Block III Tank, Combat Mobility Vehicle, Advanced Field Artillery System, the Future Infantry Fighting Vehicle on a heavy level protection chassis, and the Line-of-Sight Anti-tank (LOSAT) and Future Armored Resupply Vehicle on a medium level protection chassis. The first variant, the LOSAT, is scheduled for fielding in the mid 1990's. The Block III Tank will be the lead vehicle of the heavy protection level chassis.

The Army Aviation Modernization Plan has already been described in the introduction. One of the major premises in developing this plan has been that funding will continue to be constrained so that older aircraft need to be retired with a concurrent force structure reduction. The chart below depicts this more capable, downsized force.

***Aviation Modernization Plan***




A major objective in balancing the six major aircraft category capabilities in the AAMP - attack, reconnaissance, lift, cargo, intelligence and electronic warfare, and special operations aviation - is to ensure that every weapon system procured achieves its full potential in combat. The synergy achieved by an aviation force fully integrated with the other members of the combined arms team is readily apparent in the capacity of attack helicopters to rapidly concentrate combat power.

*AH-64 Apache*

A quick-reacting attack helicopter fleet can disrupt and destroy moving armored columns and other high value targets wherever an enemy is attacking. The AH-64 Apache has been designed to provide this capability as a principal anti-armor weapon, complemented by the AH-1F Cobra.

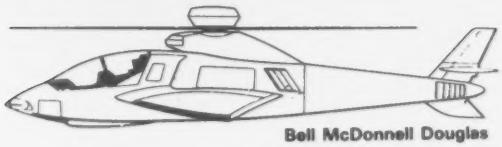
*Apache Firing Hellfire*

The Apache is highly mobile and capable of providing direct and indirect aerial fire during day, night, and limited visibility operations. The main armament of the Apache is the highly lethal and accurate Hellfire missile. Various combinations of Hellfire, Hydra-70 rockets, and 30MM ammunition may be employed depending upon mission

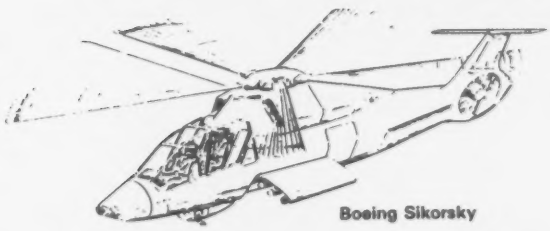
requirements. As of January 1989, 437 Apaches have been delivered and 402 fielded. FY90 R&D money continues the Airborne Adverse Weather Weapon System (AAWS), which is being developed to provide a fire-and-forget Hellfire anti-armor missile. This will allow the Apache to remain hidden from anti-aircraft fire shortly after firing the missile. There are 11 AH-64 Attack Battalions deployed and ready for combat including four battalions deployed to Europe. The program calls for a total procurement of 975 AH-64s for a force structure of 48 Attack Battalions.

## LHX DEMONSTRATION/VALIDATION

*Light Helicopter (LHX)*



Bell McDonnell Douglas



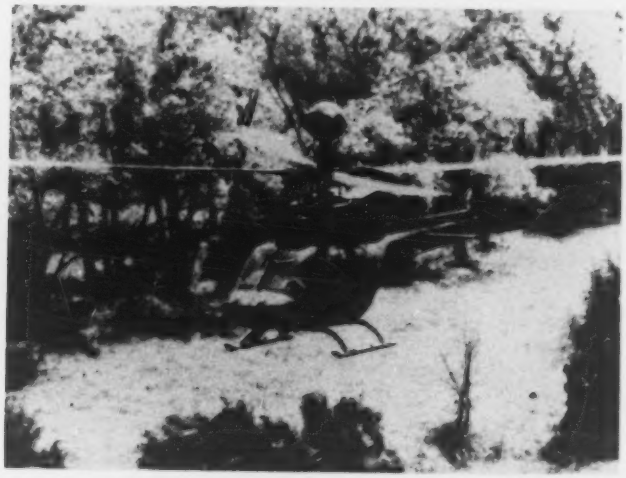
Boeing Sikorsky

LHX will replace the AH-1, OH-6, and OH-58 light helicopter fleet and complement the AH-64. The light fleet is approaching obsolescence and will be unable to meet the growing Soviet threat of the mid-1990's and beyond. Missions of LHX include armed reconnaissance and light attack with an inherent air-to-air capability. The LHX will provide a highly reliable, easily maintained weapons system with the lethality and survivability necessary for deployment on the battlefield of the future. LHX will have enhanced combat capability through the use of advanced technologies in the Mission Equipment Package (MEP), airframe and engines. Enhancements in target acquisition, night pilotage and navigation systems expand the warfighting capability of Army aviation into the hours of darkness and adverse weather.

Demonstration/Validation (DEM/VAL) of LHX, which began in November 1988, will support the December 1990 Full Scale Development (FSD) decision. DEM/VAL objectives are the demonstration of key MEP components, the definition of a common MEP architecture for LHX and future block upgrades to the current production helicopter fleet, and the final definition of performance requirements. DEM/VAL and FSD schedules support an initial operational capability for the LHX in November 1996.

LHX will be powered by two, 1200 shaft horsepower T800 engines. The T800 is continuing on schedule, on cost, and exceeding performance estimates. The T800 engine employs advanced engine technology to obtain a high power to weight ratio with low specific fuel consumption. Preliminary flight rating testing will be completed in 1989 followed by engine qualification testing.

LHX is a key conventional force initiative that will enhance the conventional warfighting capability of the Army while remaining within constrained force structure and funding projections.

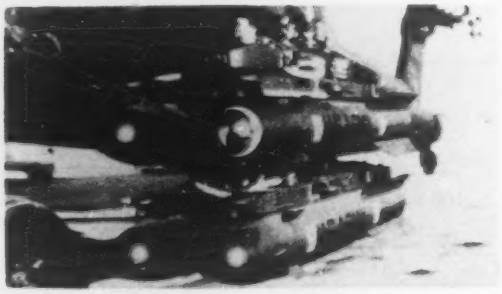


*Army Helicopter Improvement Program (AHIP)*

Scout helicopters perform the vital reconnaissance mission as well as intelligence, surveillance and target acquisition and designation. The Army Helicopter Improvement Program (AHIP), or OH-58D, gives the Army the finest scout helicopter in the world. AHIP employs a thermal imaging system, laser range finder/designator and high power television incorporated into a mast mounted sight that provides superior detectability and survivability. Operating day or night under hot and adverse weather conditions, AHIP provides command and control, target acquisition and target designation. The Army intends to purchase 375 AHIP's for fielding in Cavalry and Field Artillery Aerial Observation units. Air-to-Air Stinger capability, which is incorporated into AHIP beginning in FY90, will provide security against threat aircraft.

*AHIP Under Cover*

Hellfire is a laser guided missile that has a longer standoff range and shorter time of flight than the TOW missile system. It can be employed in a wide variety of modes including autonomous, ground remote, airborne remote, direct or indirect fire, and rapid or ripple fire. Hellfire is currently produced by Rockwell International and Martin Marietta. Rockwell is currently behind schedule in missile deliveries due to technical problems which were resolved in November 1988; they expect to recover schedule in June 1990. Martin Marietta is delivering on schedule, thus the Army and Navy requirements are being met.



*Hellfire Missile*

Hellfire has been in full production since 1986. FY90 funds are for 3102 missiles. Ongoing missile lethality improvements to defeat the future threat include an improved tandem warhead, and digital autopilot which will be cut into production in FY90 and FY93 respectively. Future improvements of the laser seeker are planned to enhance the missile's capabilities against countermeasures. These improvements will ensure the Hellfire's effectiveness into the 1990's.

Other direct fire anti-armor weapons available to soldiers conducting close operations include the TOW and AAWS missiles.

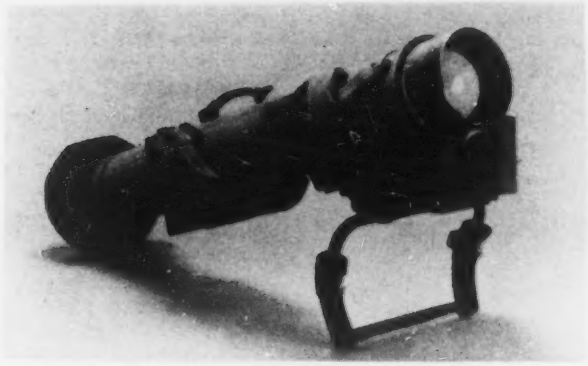
*TOW 2 Missile*

TOW has been the Army's primary heavy antiarmor/assault weapon system since 1968. It is employed on the Improved TOW Vehicle (ITV), the Armored Personnel Carrier, the High Mobility Multipurpose Wheeled Vehicle (HMMWV), the AH-1S Cobra Helicopter and the Bradley Fighting Vehicles. TOW continues to be improved to meet the latest armor threats. The TOW 2A was fielded in 1987; it will be followed by the TOW 2B, a top attack version of the missile currently under development. The TOW 2B is scheduled to be cut into production in FY90. Improvements to the system concentrate on increasing its lethality against the evolving threat while increasing gunner survivability.

*Advanced Antitank Weapon System - Medium*

The AAWS-M is the highest priority development program for our dismounted infantry forces. It replaces the Dragon, which has been in the field since 1972 and has considerable deficiencies. The AAWS-M program will give the infantryman a medium antitank weapon system portable by one man, and capable of defeating the projected Soviet armor threat. It will allow the soldier to operate effectively in battlefield environments filled with obscurants and electro-optical countermeasures. An Imaging Infrared AAWS-M currently under development will guide the missile to its target. The proof of principle flight tests and warhead lethality tests were completed in November 1988.

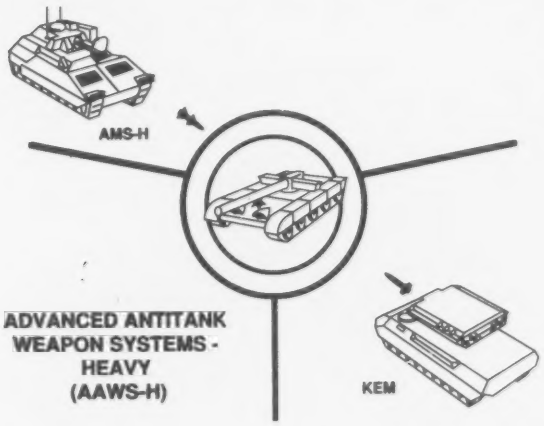
***Advanced Antitank Weapon System - Medium***



In February 1989 the Army, with Marine Corps participation, selected one of three competing contractor teams. In 3rd Qtr FY89 the selected contractor team, Texas Instruments and Martin Marietta, will proceed into a 3-year Full Scale Development phase followed by a two-year Low Rate Initial Production in which each contractor will produce a specified number of weapons. The third year buy will begin Full Scale Production and be full competition between the two contractor teams resulting in a split buy. AAWS-M is scheduled for fielding in FY94.

The AAWS-H program will develop crew served replacement system(s) for the TOW on all platforms (Bradley, Improved TOW Vehicle, High Mobility Multipurpose Wheeled Vehicle and potentially Cobra). The different characteristics of these platforms and their unique roles on the battlefield require separate solutions. The potential thus exists for multiple systems to satisfy these requirements.

***Advanced Antitank Weapon System-Heavy***



AAWS-H is potentially a family of weapon systems consisting of Kinetic Energy Missile System (KEM) and Advanced Weapon System-Heavy (AWS-H). The KEM will be developed as a Line-of-Sight Antitank (LOSAT) replacement for the Improved TOW Vehicle dedicated antitank system; the AWS-H will eventually be developed as the replacement for TOW. KEM and AWS-H will be capable of operating out to maximum range of direct fire combat engagements, will provide a greater rate of fire than TOW and will perform day or night in adverse weather, and through obscurants.

KEM is in the Proof of Principle phase, to be completed by 4th Qtr, FY90. KEM, a joint Army/Air Force/Marine Corps program, is demonstrating the basic concept. In August 1988 the Chief of Staff of the Army approved the decision to accelerate the KEM prototype development effort.

AWS-H efforts are geared toward fire control improvements for current and future missiles. An RFP was released in September 1988 for the Imaging Infrared (IIR) seeker Technical Demonstration.

Full Scale Development is scheduled for FY91 with competitive selection of a contracting team for AWS-H and KEM that will compete in first production beginning FY94.

*M109 155 MM Howitzer Improvement Program (HIP)*

The M109 provides the primary indirect fire support to the maneuver brigades of armored and mechanized infantry divisions. Ongoing modifications will extend its useful life to the 21st century. Low rate initial production (LRIP) of 19 M109 HIP modification kits will begin during FY89, following completion of operational testing. When fielded in FY91, the M109 HIP will have the capability of autonomous operations with its onboard fire control system and positioning/navigation system, with significantly improved survivability, responsiveness and reliability. In FY90, 40 modification kits will continue the LRIP phase. A total of 1,700 M109A2/A3 howitzers will receive the HIP modification. The M109 Howitzer Improvement Program is a cooperative program with Israel.



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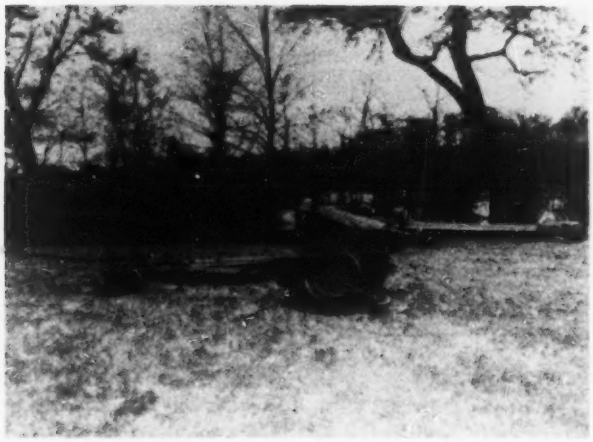
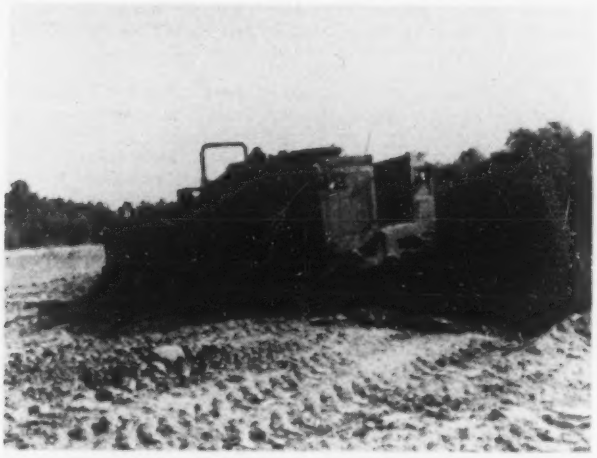
*Light Howitzer M119*



Initial fielding of the M119, the Army's new lightweight 105MM howitzer, is scheduled for December 1989. The M119 will add needed firepower and improved range and reliability to rapidly deployable light infantry, airborne and air assault light divisions. The M119 is towable behind the HMMWV and air transportable by the Black Hawk helicopter. It is a nondevelopmental item (NDI) procurement of the L119 British Light Gun. In FY90 all production shifts from the UK to the US arsenal system and procures 75 howitzers. The Army intends to purchase 548 weapons.

***Multiple Launch Rocket System***

MLRS is a free flight, multiple launch rocket system with a Dual Purpose Improved Conventional Munitions (DPICM) warhead. MLRS supplements cannon artillery fires by delivering large volumes of firepower in a short time against critical, time-sensitive targets. The MLRS system includes the M270 self-propelled tracked launcher, disposable launch pod containers (LPC), and rockets. The launcher carries two LPCs of six rockets each, a total of 12 rockets. System growth is planned by adding Terminal Guidance Warhead (TGW), chemical warhead, Sense and Destroy Armor (SADARM), and Army Tactical Missile System (ATACMS). Twenty-four MLRS batteries have now been fielded and six FORCES batteries are in place. The FY90 program continues the second MLRS Multiyear Procurement (MYP). In FY90 and FY91 the Army will procure three batteries in each year. European production of MLRS launchers and rockets is scheduled to begin in 1989.



*Armored Combat Earthmover (ACE)*

The M9 ACE has impressed field commanders with its diverse capability since its initial fielding in 1986. The ACE is a highly mobile, armored earthmoving vehicle that can dig, doze, haul and scrape. The ability to perform these tasks with forward elements assures that friendly force momentum is maintained in the offense, that enemy forces are slowed, channelized and made more susceptible to friendly fire in the defense while providing protected positioning from which our weapon systems can fight. It is fast enough (up to 30 mph) to keep pace with modern tanks on the battlefield and offers the operator protection from small arms fire, artillery fragmentation and NBC agents. Earthmoving operators in Vietnam were unprotected and vulnerable to small arms fire. The ACE will significantly enhance the support role of combat engineers on the modern battlefield.

The 7th Infantry Division (light) was the first unit equipped with seven of the low rate initial production (LRIP) vehicles. Deliveries of the full production vehicles to the field is scheduled to begin in the March-June 1989 time frame.

In FY90 the program will buy an additional 132 ACEs.

***Nuclear, Biological, and Chemical Reconnaissance System (NBCRS)***

Nuclear, Biological, and Chemical Reconnaissance System (NBCRS)

The NBC Reconnaissance System (NBCRS) is a fully integrated NBC detection, warning and communication system that will be used in conjunction with conventional reconnaissance elements. The system will detect, identify, and mark areas of NBC contamination; collect and store soil, water and vegetation samples for later analysis; designate lanes of clear passage for troop movement; and transmit NBC information to area commanders. This is a new concept which does not replace an old system. Basis of issue is 6 per heavy division and armored cavalry regiment; 36 per corps. The first unit equipped will be in the early 1990's. An improved version of the NBCRS will be fielded in the middle to late 1990's.

***120MM Mortar***

The 120mm mortar is a Nondevelopmental Item (NDI) procurement to replace the WWII vintage 4.2 inch heavy mortar used in heavy divisions. The system will be employed in two variants: a towed version and a carrier version that will be mounted in the M106A2 Mortar Carrier. The weapon and a family of nondevelopmental ammunition is currently undergoing testing for type classification during 1989. Initial fielding of the towed variant is scheduled for 4th Qtr, FY90 to the 9th Infantry Division. 167 mortars will be procured in FY90. The 120mm mortar will provide better growth potential as a result of the larger cartridge, training commonality with the 60MM and 81MM mortars, improved range, and interoperability with more of our NATO partners. The 120mm mortar program includes development of a family of enhanced ammunition (HE, Smoke, and Illumination). Initial fielding will be limited to HE and Smoke rounds.

***Small Arms***

A remaining area of importance in the close operations area is the direct fire of the infantry, small arms.

The most notable small arms systems currently in procurement include the M9 Personal Defense Weapon, M16A2 Rifle, the M249 Squad Automatic Weapon (SAW), and the MK19-3 40MM Automatic Grenade Launcher. All of these small arms programs are on multiyear contracts.

The M9 is a 9MM semi-automatic pistol designed to replace the .45 and .38 cal pistols in the DoD inventory. It is capable of firing NATO standard 9MM ammunition. Procurement has been ongoing since 1985 with over 140,000 pistols already delivered. A follow-on multiyear contract for the 9MM will be awarded in late FY89.

The M16A2 is an improved version of the M16A1 and is being issued as the Army's primary combat rifle. It is a lightweight, air cooled, gas operated, low impulse rifle firing from either twenty or thirty round magazines. To date, over 223,000 weapons have been fielded. Some M16A1 rifles will be converted to the M16A2 during depot overhaul using modification kits.

*Squad Automatic Weapon (SAW)*

The SAW is a lightweight, one-man-portable machine gun designed to replace the two M16A1 Automatic Rifles in each infantry squad (on a one-for-one basis). Like the M16, the SAW is a 5.56MM weapon. It is capable of a cyclic rate of fire of 750 rounds per minute with a maximum effective range of 800 meters. The SAW is currently in its second procurement and has been fielded both in light and heavy US forces both in the CONUS and OCONUS.

The MK19-3 40MM Automatic Grenade Launcher is an ongoing procurement initiated by the Navy and assumed by the Army in 1988. The weapon will replace some M2 (.50 cal) and M60 (7.62mm) machineguns on a variety of vehicles. It is effective at ranges up to 2200 meters. The weapon is capable of a cyclic rate of fire of 325 rounds per minute and will provide significant additional fire power to front line units as well as combat support units engaged in rear area combat operations.

*Ammunition Modernization*

A critical part of Army modernization is the modernization of ammunition across the spectrum of the battlefield. New munitions to be fielded during FY90 include the 120MM and 105MM Kinetic Energy Tank Rounds, 105MM High Explosive Rocket Assisted (HERA) howitzer cartridge, 120MM mortar weapon system ammunition, and the Product Improved VULCAN Air Defense System (PIVADS) 20MM ammunition, and two new mine systems: Multiple Delivery Mine System (VOLCANO) and Modular Pack Mine System (MOPMS).

These new munitions will enhance and increase range and lethality of existing weapon systems. The 105MM Kinetic Energy Tank Round will greatly enhance the armor-killing capability of the 105MM M1 series tanks. The HERA projectile will increase both range and lethality of artillery support for light Infantry forces. The 120MM mortar ammunition will enhance mortar fire support throughout the force. The new PIVADS' 20MM cartridge, with greater range and lethality, will enhance ground forces' defense against enemy aircraft. The fielding of these munitions will significantly improve Army combat power throughout the active force.

***Ammunition Modernization***

In support of the tank modernization program, the Army must continue the vigorous R&D effort in the Armament Enhancement Initiative (AEI) arena where previous efforts are now coming to fruition. The fielding of AEI rounds meets the lethality requirements imposed by the battlefield introduction of advanced Threat armor. For the same reason, the Wide Area Mine (WAM) must continue as a high priority development item.

The modernized 155mm Artillery-Fired Atomic Projectile, will provide improved range, lethality reliability, and command and control over its predecessor when fielded in the 1990's. It will provide advantages in survivability and effectiveness of tactical nuclear capability for US and NATO 155mm artillery units.

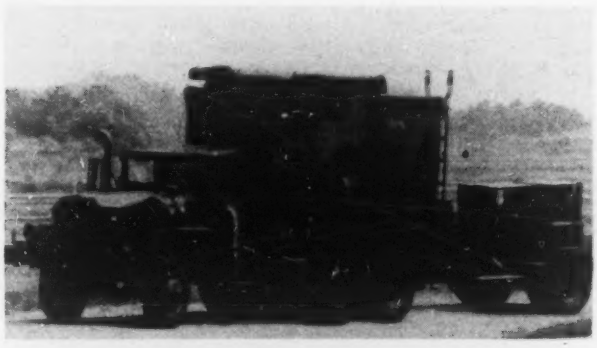
# DEEP OPERATIONS

Deep Operations allow us to win the Close Operations by shaping the conditions in which future close operations will be conducted. The activities typical of deep operations include the surveillance and acquisition of enemy targets, the disruption and destruction of these targets through deep fires and/or maneuver, the deception of the enemy, actions to counter the command and control systems of the enemy, and the command and control of our own forces. These combined efforts prevent successive echelons of enemy forces from overwhelming our units in close operations. Our qualitative edge in equipment and soldiers can then overcome the Soviet's quantitative edge.

Currently our forces do not have the full capabilities necessary to execute deep operations to the extent envisioned by AirLand Battle doctrine. Joint programs with the Air Force provide for the majority of the deep operations requirements, but we are also developing capabilities on our own to better execute deep operations.

To enable force commanders to extend their target attack capability to more than 100 kilometers deep into the enemy's force array, the Army and Air Force are developing JSTARS. JSTARS is a battle management and target attack control system that will detect, track and assist in attacking moving and fixed tank-sized targets. The Army is specifically developing the Ground Station Module (GSM) for tactical receipt of JSTARS data while the Air Force develops the airborne platform, radar and data links.

***Joint Surveillance and Target Attack Radar System (JSTARS)***



***Ground Station Module (GSM)***

Target Information will be transmitted through the secure data links mounted on the E8 (militarized Boeing 707) airframe to multiple GSMs. The GSM will evaluate and transmit tactical data from airborne radars to Army C3I nodes at corps and division headquarters and MLRS ATACMS battalion headquarters. JSTARS will also share information with other intelligence and fire support systems.

The GSM and Airborne elements are in Full Scale Engineering Development. The Army restructured the GSM program to incorporate nuclear/blast hardening and NBC filtering into a Block II GSM configuration. A European field test demonstration with the fully operational GSM and E-8 is scheduled for FY92.

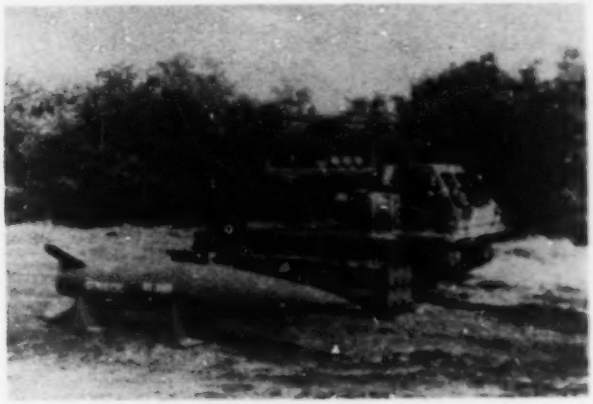
***Joint Tactical Fusion Program/All Source Analysis System (JTFP/ASAS)***

The All Source Analysis system (ASAS) is designed to provide field commanders with Intelligence tools necessary to successfully prosecute the Deep Attack. ASAS will automate command and control of Intelligence/Electronic Warfare (IEW) operations. It will also generate a near real-time picture of the enemy situation to guide employment of maneuver forces and systems such as the Joint Surveillance and Target Acquisition Radar System (JSTARS) and the Army Tactical Missile system (ATACMS). The ASAS will use state-of-the-art minicomputers to speed the analysis process and improve accuracy. The Joint Tactical Fusion Program is developing ASAS in parallel with the Air Force Enemy Situation Correlation Element (ENSCE).

The ASAS program employs an evolutionary acquisition strategy. The ASAS/ENSCE architecture is modular. The three major hardware modules within the ASAS/ENSCE system are: Forward Sensor Interface and Control (FSIC) module, which relays data from ground based sensors/sources in forward areas back to the data processing modules and provides the interface between the data processing modules and the area communications network; the ASAS/ENSCE Interface Module (AIM) or Dual AIM (DAIM), which processes intelligence data; and, the Portable ASAS/ENSCE workstation (PAWS), which is the primary user interface with the system.

Field trials of the FSIC and AIM took place in December 1986. A Limited Capability Configuration (LCC), comprised of the FSIC, AIM and PAWS is completing development and will be delivered to III Corps, Fort Hood, TX in March/April 1989. Force Development Test and Experimentation (FDT&E) will commence in July 1989 at Fort Hood. The Initial Operational Test and Evaluation (IOT&E) will be completed in FY91 and the Milestone III decision (production) is scheduled for 2nd Qtr, FY92. The objective system will evolve through pre-planned product improvements and software refinement based on user feedback.

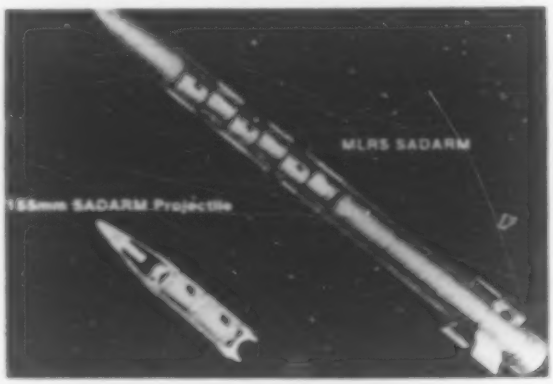
***Army Tactical Missile System (ATACMS)***



ATACMS is designed to engage high priority land targets at ranges beyond the capability of cannons, rockets, and the Lance Missile System. ATACMS is a conventional semi-ballistic missile that will fired from the existing Multiple Launch Rocket System (MLRS) launcher; each launcher will carry two ATACMS missiles, each with 1000 Antipersonnel Antimateriel (APAM) bomblets. To the firing units, ATACMS is just another round of crated ammunition, transported and fired from any MLRS launcher. The ATACMS thus extends the capability of the MLRS launcher and crew at no cost in terms of additional manpower or equipment to the firing units. The mission is to interdict, delay, disrupt and destroy the second echelon assault forces, command and control elements, and logistic support units. Engineering Development Testing continued through January 1989 with six of eight flights being completely successful. In the 5th and 6th flights the warhead failed to function, however, fixes have been incorporated into the warhead to alleviate failures of this nature.

***MLRS Terminal Guidance Warhead (TGW)***

The development of a Deep Attack Antiarmor capability is contingent upon the successful development of a smart submunition. The US is currently involved in a multinational development of a Millimeter Wave Terminal Guidance Warhead (TGW) Rocket for MLRS. Each MLRS-TGW rocket will carry three Terminally Guided Submunitions (TGSM). The MLRS M270 launcher carries two Launch Pod Containers with six rockets each: a total of 12 rockets containing 36 TGSMs. Each TGSM is capable of locating, attacking and destroying a threat armor vehicle using its Millimeter Wave (MMW) seeker and tandem shaped charge warhead. This joint venture with our European partners will help meet an urgent need to defeat hard targets such as moving and stationary armored vehicles before they are committed into the close battle. The TGW program begins Full Scale Development in FY92.




***Sense and Destroy Armor (SADARM)***

SADARM is a relatively low cost, sensing submunition designed to detect and destroy lightly armored vehicles, primarily self-propelled artillery. One of the Army's new family of fire and forget "SMART" munitions, SADARM will be used primarily in an artillery counterbattery role. The submunition is launched via

155mm howitzers or the Multiple Launch Rocket System (MLRS). After launch, the submunition is dispensed over the target area and searches for stationary or slow moving armored vehicles using a combination millimeter wave/infrared, dual-mode sensor. Once a target is detected, SADARM fires an explosively formed penetrator which, travelling at an extremely high velocity, perforates the top of the target.

SADARM is currently in Full Scale Development; projectile and rocket (MLRS) tests will continue through early 1992. Type Classification is projected for 2nd Qtr, FY92 and the First Unit Equipped (FUE) dates are 4th Qtr, FY93 (155mm) and 3rd Qtr, FY94 (MLRS).

***NATO 155MM Autonomous Precision Guided Munition (APGM)***

The US has been assigned lead nation responsibility for the 155mm Autonomous Precision Guided Munition (APGM), a NATO cooperative development program to develop an anti-armor, fire-and-forget artillery projectile to be fielded during the mid-to late 1990's. Eight NATO nations have committed their combined resources to the effort. During 1988, two international consortia were selected for award of three-year expanded fensibility contracts. Each consortium consists of firms from each of the eight participating nations. NATO APGM will complement the counterfire capability of the 155mm and MLRS SADARM submunition programs, and the anti-armor capability of the MLRS Terminal Guidance Warhead (TGW) international cooperative development program.

***Follow On To Lance (FOTL)***

FOTL is required as a replacement for the aging Lance nuclear missile system and is essential to maintaining the NATO non-strategic nuclear triad. The SACEUR has identified a critical need for FOTL to meet the Corps and Theater Commander's requirements for delivery of nuclear fires against high priority battlefield targets of the Warsaw Pact. FOTL is emphasized as a key element of 1983 Montebello Decision which outlines nuclear modernization plans supported by NATO. The Army initiated studies and analyses for FOTL in FY88, and is continuing program development in FY89. FOTL will be a nuclear missile capable of being fired from a MLRS-type launcher giving us the opportunity to realize significant force structure and cost savings. Research and development funds in FY90 and FY91 will initiate a Full Scale Engineering Development (FSED) contract.

***Special Operations Aviation (SOA)***

The SOA Program will develop and procure sophisticated helicopters capable of deep penetration missions (infiltrating and exfiltrating special forces at low levels through unfamiliar mountainous terrain, at night, and in adverse weather). Phase I of the program consists of the development of one prototype and 16 production MH-47Es as well as one prototype and 22 production MH-60Ks. Phase II consists of the procurement of an additional 34 MH-47Es. To ensure our SOA pilots are adequately trained, a combat mission simulator for each type of aircraft will also be developed.

Significant features of the aircraft are: fully integrated cockpit common to both type aircraft, up-rated engines, forward looking infrared sensors, terrain following/terrain avoidance radar, and extended range fuel capacity (internal/external tanks and air-to-air refueling capability).

In FY90 the final 11 MH-47Es (Phase I) and the first 11 MH-60Ks will begin the modification process. The long lead items for the 34 MH-47Es of Phase II will also be procured. Future funds will modify an additional 11 MH-60Ks and 34 MH-47Es.

***Desert Mobility Vehicle (DMVS)***

The DMVS program will modify High Mobility Multipurpose Wheeled Vehicles (HMMWVs) to perform Special Operations direct action and deep reconnaissance missions in desert/arid environments. Currently, SOF operational teams lack the capability to rapidly infiltrate, exfiltrate and traverse long distances in assigned mission areas with a high probability of survival. In FY90, 63 HMMWV armament carriers will be modified and the procurement of 48 trailers will be initiated.

***Special Operations Forces (SOF) Communications***

The Army continues to make SOF Communications a priority item. The SOF Communications program upgrades and enhances present SOF capabilities, replaces obsolete equipment and creates new technological advancements for active and reserve SOF. These communications systems support the SOF missions requiring low probability of intercept and detection in a lightweight, manportable, secure and reliable package. Fifteen separate communications programs, as validated by USCINCSOC, are supported by Army resources.

***Intelligence - Electronic Warfare (IEW)***

The IEW mission includes locating, deceiving, degrading or destroying Warsaw Pact C3 systems in support of battle management by the Commander. Such disruption of Warsaw Pact communications is one of the key means of slowing the timely massing of their individual units, which exercise far less autonomy than NATO units.

The Army is fielding a complementary mix of ground-based and airborne signal exploitation and jamming systems while continuing to improve IEW system capabilities. For airborne deep operations Guardrail and Quick Look perform the interception and location tasks while Quick Fix has a limited capability to perform the countermeasures task. The OV-1D MOHAWK continues to provide organic imagery collection to the Corps commander. There are also ongoing efforts to develop modular IEW sensors for Unmanned Aerial Vehicle (UAV) payloads to provide IEW capabilities for deep penetration missions.

*Quick Fix*

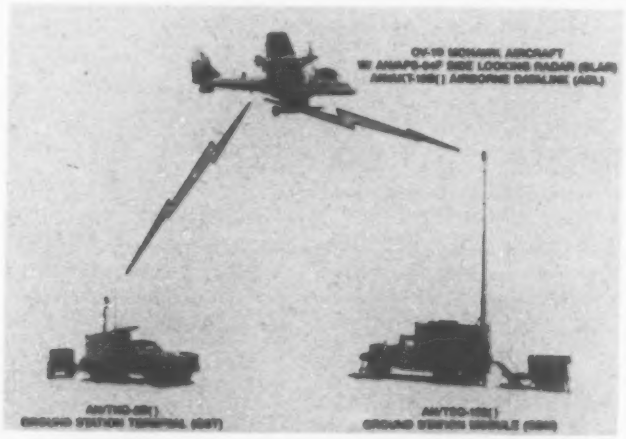
The EH-60A, Quick Fix II (which uses the Black Hawk airframe) is a tactical, electronic warfare, heliborne jamming system. It gives the division commander the capability to conduct limited electronic countermeasure operations at ranges deeper than ground based systems. The First Unit Equipped date for Quick Fix II was May 1988. The Army has procured 66 aircraft.

*Guardrail*

Guardrail is a combination of fixed-wing airborne sensors and ground processing facility which provides real time critical information about enemy C3I disposition and location in developing intelligence for combat planning, tactical maneuver, and targeting. The future Guardrail Common Sensor system, which combines communications and electronic intelligence sensors, will use the RC-12K aircraft. It will enter the inventory in early 1991. Future plans call for upgrading all Improved Guardrail V's to the Guardrail Common Sensor

configuration. The RV-1D fleet will be retired as Guardrail Common Sensor is fielded. The first unit set will be retired in FY91, and the retirement will be complete in FY95. Due to the retirement schedule no more RV-1's will be inducted into the Programed Aircraft Restoration and Service Life Extension Program (PAR/SLEP) after 2nd Qtr FY89.

The Quick Look System provides the corps and division commanders with the location and type of threat noncommunication emitters day or night in any weather conditions. Quick Look's airborne electronic equipment is mounted in the RV-1D MOHAWK aircraft. The remainder of the Quick Look system is mounted in several surface vehicles.



*OV-1D Mohawk*

Since its inception, the MOHAWK aircraft has been the only organic imagery collection asset available to the Corps commander. Currently, there are 10 aircraft in each Aerial Surveillance Company of the Military Intelligence Battalion, Aerial Exploitation. Imagery intelligence collection is accomplished by using Side Looking Airborne Radar (SLAR) data linked to a ground terminal and by using photographic camera systems. A limited number of Infrared (IR) sensors can also be employed on the OV-1D. Moving Target Indications (MTI) provided by the SLAR ensures efficient targeting by Corps deep strike weapons systems.

We will continue to work toward a more fully automated C3 structure, coupled with modernized weapon systems, to improve our Deep Operation's capability.

# REAR OPERATIONS

Rear operations are designed to assure freedom of maneuver and continuity of operations for all activities rearward of elements in contact. Rear operations normally include assembly, movement, and positioning of reserves and long range fire support; movement, stockpiling, and distribution of war materiel; maintenance and field services; maintenance of lines of communication; and the defense against air, ground, and missile attack. At the operational level, rear operations focus on preparing for the next phase of the campaign.

Our modernization of systems needed to conduct these rear operations is progressing well. The highlights of these systems follow. As you review these systems, keep in mind that the employment of many of them will require that they operate in close and deep operations. Under normal conditions, these systems are usually based in the rear area. For example, utility transport systems such as the Black Hawk, the Chinook, and tactical wheeled transporters all enter the close operations area to deliver the supplies and personnel required to sustain these operations.

***Tactical Transportation***

The Army continues to upgrade its tactical wheeled vehicle fleet to provide better supply support, improved unit mobility, enhanced heavy lift for ammunition and fuel, and more capable heavy equipment transport.

***High Mobility Multipurpose Wheeled Vehicle***

The light fleet will be strengthened by a new competitive multiyear contract for approximately 36,000 HMMWs to be awarded in late FY89. The HMMW has been an important addition to our light fleet in the active force, the ARNG

and USAR. It is a highly mobile, diesel powered, 4-wheel drive tactical vehicle that may be configured as a cargo troop carrier, armament carrier, ambulance, and shelter carrier. It also serves as a platform for the TOW anti-tank weapons carrier, and Pedestal Mounted Stinger.

Procurement of the SUSV supports activation of the 6th Infantry Division (Light) in Alaska. SUSV is a tracked vehicle capable of traversing snow and tundra regardless of depth in all seasons. It is used to conduct operations in northern and mountainous regions and can carry subsistence equipment, ammunitions, and supplies required by small units. It can transport 17 fully equipped soldiers or a 4,400 pound payload, and tow a trailer or light howitzer. SUSV is a Nondevelopment Item (NDI) and has four variants: cargo, ambulance, flatbed, and command and control.

The initiation of the competitive RDT&E phase of the Family of Medium Tactical Vehicles (FMTV) program in FY89 will provide an improved medium truck family using today's automotive technology to replace aging 2 1/2 ton trucks and help alleviate the critical shortage of 5 ton trucks. Our medium vehicle fleet, which is the Army's workhorse for our tactical mobility mission, will continue to endure vehicle shortages, particularly in the 5-ton class, hence the emergence and success of the FMTV becomes even more critical to our efforts to improve the medium vehicle fleet.

*10-Ton Truck*

We will continue to field additional 10 ton Heavy Expanded Mobility Tactical Trucks (HEMTT) from the FY89 procurement and M915/916 Line Haul Tractors. Again this year we are requesting relief from the National Defense

Authorization Act FY88/89, which directed continued procurement of HEMTTs, to obtain permission to stop procurement based on affordability and established higher priorities of other equipment. The Palletized Loading System (PLS), a 16.5 ton tractor with companion trailer and self-load/unload capability, will complete prototype development and begin production in FY90. Fielding of PLS will provide great increases in Corps ammunition distribution efficiency and productivity as well as support NATO interoperability.

The last addition to the heavy fleet is the Heavy Equipment Transporter (HETS) which will provide the ability to support, deploy and evacuate the M1 series tank. We expect to begin initial receipt of the HETS semitrailer in late FY90 while continuing testing and preparation to produce the HETS tractor in late FY91.

The Army will lay the foundations in FY90/91 for the continued improvement of all components of its tactical wheeled vehicle fleet with strong emphasis on NDI programs (FMTV, PLS, HMMWV).

*Tactical Wheeled Vehicles Modernization Plan*

The Tactical Wheeled Vehicle Modernization Plan (TWVMP) will provide an objective plan for equipping the Total Army with a capable, cost-effective and stable wheeled vehicle fleet through the year 2020. The goals of the TWVMP are to: (1) Fill Army Tactical Wheeled Vehicle (TWV) requirements with a capable, supportable, modernized fleet; (2) Minimize cost of ownership through a program of procurement and service life extension programs (SLEP); (3) Establish acquisition strategies for new procurements which minimize turbulence in the manufacturing base; (4) Establish a TWV useful life program as the baseline for making vehicle retirement and SLEP decisions. The plan will establish prioritized acquisition strategies for the Total Army which are executable within programmed resources, integrated distribution/redistribution strategies, and a detailed TWV program concept. The TWVMP is scheduled for completion in 1st qtr, 1989.

*UH-60 Blackhawk*

***Blackhawk***

The Army's primary tactical lift helicopter is the Black Hawk, with missions of troop assault, resupply of troops in combat, command and control (C2) and aeromedical evacuation. It can move a squad of 11 troops or 8000 pounds of cargo, internally or externally, in all geographical conditions. Its enhanced survivability plus technological reliability, availability and maintainability (RAM) improvements give it a staying power never before achieved in a helicopter. More than 1000 Black Hawks have been delivered to the Army worldwide. A more powerful engine will be added, starting in 1989.

***CH-47D Chinook***

The "D" model improvements being incorporated into the Chinook, our only medium lift helicopter, will extend the service life of the fleet beyond the year 2000. Configured to move both internal and external cargoes, the CH-47D allows for the rapid delivery of troops and equipment.

By the end of 1988 there were 240 "D" model Chinooks in the hands of soldiers. The Chinook has achieved a mission availability rate which is five percent above the Army's standard. The planned production has been increased from 436 to 472 aircraft to be completed in 1992. FY89 completes the current multiyear contract. A second multiyear contract (FY90-92) has been signed to complete the modernization effort for the CH-47 fleet.

***Chinook With Sling Load***

# DEFENSE FROM AIR ATTACKS

Our Air Defense systems must protect all Army elements from the air threat including troop formations, depots, lines of communication, air bases, key command and control facilities, and other vital assets. A comprehensive air defense umbrella for these assets is needed at all ranges, altitudes, and for all types of operations leaving the enemy no preferred attack option. For the low altitude threat to the division we are developing and fielding the Forward Area Air Defense System. Medium and high altitude attacks are countered by the Patriot and Improved Hawk systems.

Given the improvements in threat helicopters and long range munitions, the modernization of our forward area air defense is essential. The Forward Area Air Defense System (FAADS) was initially defined by a special study group after the DIVAD Gun experience proved that one system alone, or even multiple weapons acting independently, cannot defeat the evolving Soviet air threat.

Ongoing Army programs are being combined with new technology to integrate weapons, sensors and new command, control, and intelligence systems. Relying heavily on NDI equipment and preplanned product improvements FAADS will ensure freedom of maneuver for division ground elements and protect critical division C2, fire support, and combat sustainment elements on the AirLand Battlefield.

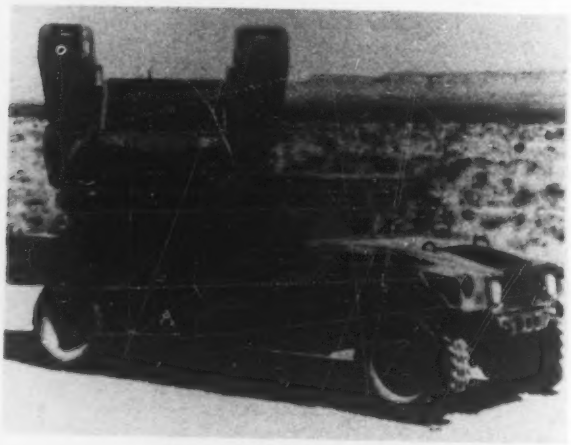
*FAADS Line of Sight Forward-Heavy (LOS-F-H)*

Line of Sight-Forward-Heavy (LOS-F-H) is an NDI program. Its role is to maneuver with the Combined Arms Team. LOS-F-H must be capable of defeating the fixed wing air threat and providing long range anti-helicopter fires. After extensive testing ADATS was selected for the LOS-F-H role and will undergo full operational testing starting in October 1989. Low rate initial production (5 fire units and 60 missiles) began in FY89. Production continues in FY90 (18 fire units and 424 missiles) following operational testing and a Milestone III decision review.

***FAADS Non-Line of Sight (NLOS) Air Defense Weapon***

Non Line of Sight (NLOS), or the Fiber Optic Guided-Missile (FOG-M) is a long range anti-helicopter, anti-tank system that can defeat targets masked by terrain and beyond the range of line of sight systems. Test Flights have demonstrated its capability to destroy helicopters flying up to 10 km from the firing unit. An Initial Operational Evaluation of FOG-M is in progress and ends in May 1989. FOG-M entered into Full Scale Development (FSD) with the contract awarded in December 1988. In FY90 the program will begin testing of the FSD prototype system and award advance procurement funds to support an FY91 Low Rate Initial Production (LRIP) buy of fire units and missiles.

***Pedestal Mounted Stinger (PMS)***



Line of Sight-Rear (LOS-R), the rearmost FAADS component, is the Pedestal Mounted Stinger (PMS), which is a lightweight, highly mobile, line-of-sight system operated by a two-man crew. Boeing's AVENGER was selected to perform this role. Utilizing the proven Stinger missile, the system provides improved reaction time, firepower day and night capability and shoot on the move capability for low altitude defense against fixed-wing aircraft and moving helicopters. PMS operates day or night primarily in the division rear areas. In FY90 the program will initiate full scale production with a buy of 122 PMS fire units.

***Combined Arms Initiatives***

Combined Arms Initiatives (CAI) provide ground and aerial combat elements an enhanced capability for self defense against enemy helicopters. These include Air-to-Air Stinger on selected Army helicopters, an improved Air Defense Sight on the Bradley Fighting Vehicle, and improved tank ammunition which provides both an anti-helicopter and anti-tank capability.

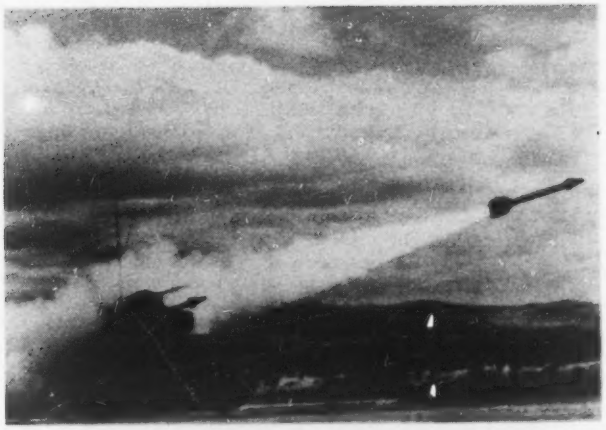
**FAAD C2**

FAAD Command, Control, and Intelligence (FAAD C2I) is an integral part of FAADS which integrates the weapon system components into a synergistic system of systems by providing rapid and reliable (1) targeting; (2) air situation; and (3) air battle management information. FAAD C2I consists of four separate but interrelated efforts: Command and Control (C2) Hardware and Software, Ground Based Sensors, Masked Target Sensors, and Identification equipment. Starting in FY90 the program will begin testing of C2 Software and certification of the Post-Deployment Realtime Interactive Simulation System, which will be used to test and verify future C2 software operations. An NDI proposal for the Ground Based Sensor is now under evaluation. Funding for the Masked Target Sensor has been deferred until FY92. Also, in FY90 two Identification devices will enter production and two will enter the demonstration/prove out phase.

***Stinger (POST) and Stinger (RMP)***

Stinger is an advanced manportable, shoulder fired air defense missile system. The Basic Stinger, fielded in 1981, uses a passive infrared (IR) homing seeker to guide on the target. An improved seeker, Passive Optical Seeker Technique (POST), which entered production in 1983, improves Stinger performance in an infrared countermeasures environment by the addition of an ultraviolet (UV) channel in the seeker and a new scanning techniques. The Stinger-Reprogrammable Microprocessor (RMP) entered development in 1984 and transitioned to production in 1985. It places all key missile guidance functions under software control. This allows the missile to be modified by software changes in an external module, rather than making expensive hardware changes to overcome future threats. Deployment of the Stinger-RMP is scheduled for FY89. Applications include Line of Sight-Rear (LOS-R), also known as the Pedestal Mounted Stinger (PMS), and the Air-to-Air Launcher mounted on selected helicopters. The FY90 Stinger-RMP program buys 4754 missiles. The Stinger-RMP Security Interlock was successfully demonstrated in October 1988.

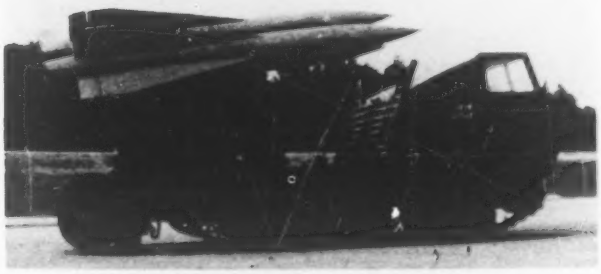
*Chaparral - Short Range Air Defense*



Chaparral provides short range air defense against low altitude air attack of forward deployed divisions and corps and theater rear areas. The Rosette Scan Seeker (RSS) guidance system was developed to provide improved infrared countermeasures. Other improvements include FLIR optical improvements, and a Nuclear, Biological and Chemical Collective Protection system.

The FY90 request will procure 422 RSS missiles. The Army National Guard will equip four battalions with Chaparral fire units by the end of FY89.

*Hawk - Protects Against Low to Medium Air Attack*

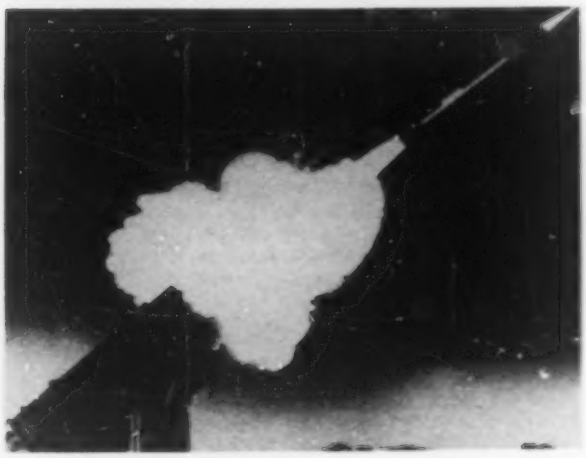


The HAWK medium range missile system provides vital air defense against low to medium altitude air attack of air bases, critical logistics installations, and corps air defense priorities. The FY90 funds will continue procurement of Phase III kits which will increase firepower and improve mobility and operator training as well as provide chemical collective protection equipment. The systems' field maintenance equipment (FME) is also being upgraded to further reduce manpower needs and improve operational availability. These product improvements will keep HAWK effective through the year 2005.

*Hawk - Protects Against Low to Medium Air Attack*

The Medium Surface to Air Missile (MSAM) System is a potential replacement for both Hawk and Chaparral in the US Army and Hawk in NATO countries. MSAM is projected to be a highly mobile and survivable system with a high volume of firepower and low manpower requirements. MSAM would be a cooperative development to support both US and European air defense requirements.

*MSAM*



*PATRIOT - Protects Against Medium to High Altitude Threat*

PATRIOT is our long range surface to air missile system which protects against the medium to high altitude threat. In future combat we must be ready for saturation raids by large numbers of sophisticated aircraft using intense electronic countermeasures. PATRIOT is designed to meet that threat with its fast reaction time, multiple engagement capability and ability to operate in a severe electronic countermeasure environment. Nine PATRIOT battalions are currently operational with one additional battalion scheduled to join our forces during 1989.

The FY90 request will provide funds for 3 fire units and 815 missiles, as well as for Ground Support Equipment that will be provided to Italy under a Memorandum of Understanding between the U.S. and Italy. The Federal Republic of Germany and the Netherlands are also participating in PATRIOT acquisition programs to provide for cooperative air defense improvements. The first NATO unit was delivered in 1986, and discussions continue with other interested NATO allies. Japan has also been licensed for the production of 26 fire units.

*Joint Tactical Missile Defense (JTMD)*

The Joint Tactical Missile Defense Program (JTMD) is designed to counter the Soviet Tactical Ballistic Missile (TBM) threat. A significant TBM threat remains even after the INF Treaty eliminated missiles with ranges greater than 500 kilometers.

TMD consists of four elements: (1) Active Defense to destroy missile in flight, (2) Passive Measures to reduce vulnerability to enemy attack, (3) Attack Operations to destroy launchers and associated equipment on the ground, and (4) C3I to link all elements together.

The Army is currently concentrating on Active Defense by upgrading the PATRIOT Missile System. PATRIOT Anti-Tactical Missile Capability (ATM) Phase 1 (PAC-1) involving software upgrades was fielded in July 1988. PATRIOT ATM Capability Phase 2 (PAC-2), consisting of a new warhead and fuse, will be fielded in the early 1990's. Negotiations are also on-going with the Federal Republic of Germany to create a Navy cooperative program for the development of a Multi-Mode Seeker for the PATRIOT missile that provides a capability greater than PAC-2.

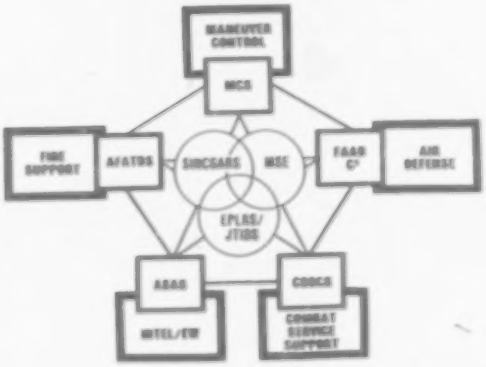
The Army intends to integrate appropriate SDIO technology into TMD programs. The major benefits from SDI will most likely be in technological areas which will come to fruition in the longer-term TMD program.

The FY90/91 request will continue development of PATRIOT PAC-2 and the Multi-Mode Seeker Demonstration with the Federal Republic of Germany.

# BATTLEFIELD SYNCHRONIZATION

A flexible, integrated and automated C3 network is needed to provide the battlefield commander with intelligence tools to fight the AirLand Battle. Our C3 mission area has the challenge of keeping pace with the Army's greatly increasing requirement for providing timely information transfer. In all of the five battlefield functional areas, maneuver control, fire support, air defense, intelligence/electronic warfare, and combat service support, information processing and data transfer is limited by manual and partially automated methods. For example, advanced weapon systems have long been in development to support the deep battle concept of the AirLand Battle Doctrine without corresponding C3 upgrades. In the near future, however, we will begin to see our C3 systems rapidly closing the gap.

**ARMY COMMAND AND CONTROL SYSTEM (TACTICAL)**




*Army Tactical Command and Control System (ATCCS)*

C3 support responds to 5 critical requirements: to rapidly collect and assess intelligence; to tightly control battlefield sensors; to engage specific targets; to effectively support maneuver; and finally, to achieve close coordination of battlefield air interdiction and close air support. The C3 network designed to meet these 5 requirements is the Army Tactical Command and Control System (ATCCS). As ATCCS has evolved, we have for the first time been able to identify and articulate requirements for common hardware and operating system software (CHS). This has been accomplished for computer processing that covers all of the battlefield requirements serviced by ATCCS as shown in this depiction of the 5 battlefield functional areas.

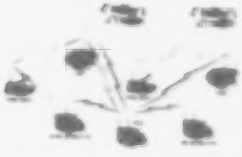
*Maneuver Control System (MCS)*

Controlling the movements of our forces is accomplished with the Maneuver Control System (MCS). The MCS provides computer aided decision support to tactical commanders and operations personnel at corps through battalion levels. Important battlefield information can be collected and reviewed, with subsequent battle plans, orders, estimates and tactical reports being produced and distributed rapidly. Purchase of the militarized MCS computers was completed in FY87. The Nondevelopmental Items (NDI) were bought out in FY88. The fully militarized device with Ada software language has been fielded to V and VII Corps in Europe, and III Corps at Fort Hood. Fielding of the NDI hardware will begin with III Corps in 2d Qtr FY89. The program is successful and has substantial momentum. The FY90 MCS request provides the funds to continue evolution of software and begin preparation for the transition of the system to use the ATCCS Common Hardware/Software (CHS).

*AFATDS*

**ADVANCED FA TACTICAL DATA SYSTEM**

- STATE OF THE ART TOTAL FIRE SUPPORT SYSTEM
- DISTRIBUTED PROCESSING
- USES ARMY COMMON (ATCCS) HARDWARE
- FIRST UNIT EQUIPPED 3D QTR FY 93



The command and control of the Fire Support functional area will be accomplished by AFATDS, a role critical to implementation of AirLand Battle doctrine. The AFATDS will provide fully automated support for the planning, coordination, and execution of close support, counterfire, interdiction and suppression of enemy fires. It will meet fire support requirements of the Army Tactical Command and Control System (ATCCS) during the 1992-2010 timeframe. Compatibility will be provided with all existing and planned U.S. and allied field artillery systems and sensors. The AFATDS will also correct the fire control and data distribution deficiencies of the current TACFIRE system with no increase in personnel requirements, with greatly reduced size, and minimized training burden. The fielding objective of the AFATDS program is to totally field both the Active and Reserve components. A milestone III ASARC will take place for AFATDS in FY89. FY90 activities include continued Full Scale Development of Fire Support software, continued system integration and test with the ATCCS CMS as well as development of installation kits and accessories to support test and initial fielding of AFATDS.

The Air Defense command and control in the forward area will be performed by the Forward Area Air Defense Command and Control (FAADC2) of the Forward Area Air Defense System (FAADS). The FAADS consists of weapon delivery elements tied together by command, control and intelligence elements which also integrate FAADS with the supported forces. The FAADC2 element incorporates a family of sensors and identification equipment (ground and aerial, active and passive) with an automatic data processing and distribution capability. The FAADC2 will correct serious deficiencies in targeting, air defense operations and force integration. This is achieved through processing and dissemination of aircraft alerting and cueing data from sensors, control orders and other air defense command and control data. Overall system integration, assembly and test will begin in FY91.

*FAAD C2*

The All Source Analysis system (ASAS) is designed to provide field commanders with intelligence tools necessary to successfully prosecute the Deep Attack. The ASAS program is covered in detail in the Deep Attack section.

As one of the principal control nodes of the Army Tactical Command and Control System (ATCCS), CSSCS supports the planning and decision making processes of the theater and tactical level commander. CSSCS provides resource management information for the functional areas of logistics, medical, financial and personnel. CSSCS provides an integrating capability for the Combat Service Support (CSS) functional areas and interfaces between ATCCS and the CSS Standard Army Management Information Systems (STAMIS). It provides an essential decision support system to both the force level and CSS commanders. The CSSCS will be deployed at separate brigades and armored cavalry regiments, maneuver and combat aviation brigades, divisions, corps, and echelons above corps. FY89 activities include Milestone I review and initial division level software demonstration at Ft Lewis, WA. An FY90 goal is to award the Objective CSSCS System Development contract.

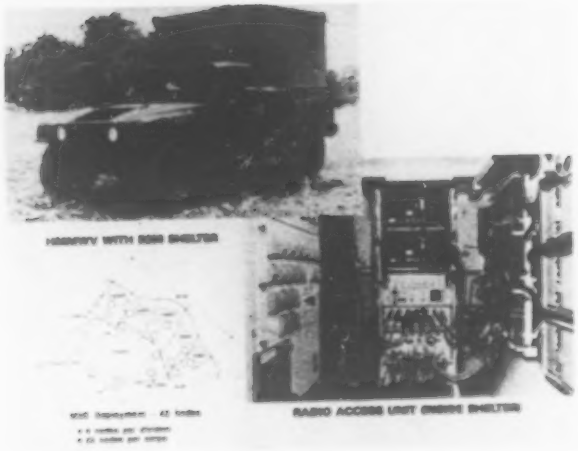
*Combat Service Support Control System (CSSCS)*

***Common Hardware Software (CHS)***

The CHS will procure 3 versions of common hardware (handheld, portable, transportable) for the Army Tactical Command and Control System (ATCCS). CHS will be provided to the five Project Managers as building blocks for ATCCS. Emphasis is placed on restricting the number of unique tactical hardware and software systems that are being fielded by the Army in order to minimize cost and maximize continuity of operations. FY89 activities include delivery of CHS to the five Battlefield Functional Area (BFA) Project Managers to conduct their hardware and software system integration, development and testing. Each BFA will use the test results as input to its CHS production decision.

***Single Channel Ground and Airborne Radio System (SINCGARS)***

The Single Channel Ground and Airborne Radio System (SINCGARS) will serve as the backbone of the Army combat net radio and provide voice and data communications for tactical command and control. SINCGARS is a family of lightweight, secure VHF/FM radios with greatly improved reliability over the radios which they replace. It can operate in an electronically hostile environment using an antijam technique known as frequency hopping. SINCGARS radios are configured in manpack, vehicular, and airborne versions. A modular approach using a single receiver-transmitter allows SINCGARS to replace five currently fielded radios. A total of 350,582 ground and 14,220 airborne radios will be procured through 2003. A limited fielding to Korea took place in December 1987. Limited Initial fielding to Army units in SOUTHCOM is planned in January 1989. Major unit fielding will begin in FY90.



*Mobile Subscriber Equipment (MSE)*

The Mobile Subscriber Equipment (MSE) is a secure, automatic digital area communications system which will provide mobile and stationary users at corps and division level with voice, data, and facsimile capability. The underlying concept of MSE is to better support the Airland Battle area communications provided at corps and below. MSE will be more mobile, less manpower intensive, and more survivable than the existing area communications facilities. The force structure identified in the current MSE contract will be totally equipped by 1994 with equipment that provides multiple communications nodes and network features which automatically bypass and reroute communications around damaged or inoperative nodes. MSE will greatly facilitate operations through its modular signal organization structure, mobility, and quick set-up and displacement capability. The system is interoperable with TRI-TAC equipment, combat net radio, commercial telephone systems, and NATO communications networks.

Procurement from the first four of seven contract awards will equip and field 12 corps signal battalions, 11 division signal battalions with associated MSE division equipment, and the Fort Gordon and Fort Sill training bases. A Follow-On Operational Test and Evaluation was concluded in November 1988.

*The Army Data Distribution System (ADDS)*

Tactical near real-time data distribution will be performed by the Army Data Distribution system (ADDS). The ADDS will give combat commanders the capability of meeting near real-time data communications and position location reporting requirements. The ADDS consists of two systems, the Enhanced Position Location Reporting System (EPLRS), a joint Army/marine program, and the Joint Tactical Information Distribution System (JTIDS), a tri-service program. The ADDS system will support data communications requirements in the five functional areas of air defense, intelligence/electronic warfare, fire support, maneuver control and combat service support.

*JTIDS Class 2 Terminal*

The EPLRS portion of the ADDS program will complete Technical Testing and the final phase of Low Rate Initial Production will begin in April 1989. During FY90 R&D efforts will be directed toward Very High Speed Integrated Circuit (VHSIC) technology insertion and Net Control Station (NCS) downsizing. The JTIDS program will continue with Class 2M Terminal and NCS development through FY90. Following completion of comprehensive testing of the ADDS, FY91 funding will initiate full scale production.

Army's Satellite Communications Program consists of the Ground Environment of the Defense Satellite Communications System (DSCS) and the Ground Mobile Force Tactical Satellite Communication Program.

The global Defense Satellite Communications System (DSCS) satisfies unique and vital command, control, and intelligence communications requirements that have been validated by the JCS.

*Defense Satellite Communications System (DSCS)*

The Army is the Executive Agent for the Ground Sub-System of DSCS. In FY89 a developmental contract was awarded for the DSCS Generic Principles Trainer (GPT), which will greatly enhance the US Army Signal School capability to train DSCS operators.

FY90 R&D efforts will apply new technology to enhance the reliability and efficiency of the system, continuation of the GPT development and continuing upgrades to the DSCS Integrated Test Facility at Ft Monmouth, NJ. FY90 procurement efforts are directed toward modernization projects which will sustain the availability of the worldwide system into the 21st century.

*Single Channel Objective Tactical Terminal (SCOTT)*

Full Scale Development is underway to provide the highly survivable, anti-jam and mobile ground terminal—the Single Channel Objective Tactical Terminal (SCOTT)—for the MILSTAR Satellite Communications System. SCOTT will operate and survive in a severe electronic warfare, nuclear, chemical and biological environment in which ground relay networks dependent upon the use of prominent terrain may be largely disrupted. Such a capability will support critical communications required by the joint, tactical and non-strategic nuclear force commanders. The MILSTAR/SCOTT system provides an enduring communications link on the battlefield in both intense jamming and nuclear environments.

The Army's FY90 program will continue development of critical pre-planned improvements to the baseline terminal design and the training simulator. Procurement funds will be used to initiate SCOTT production based on successful completion of development and operational tests in FY89.

# TECHNOLOGY BASE

Technology has changed every area of today's modern battlefield. It has, for example, improved firepower, and mobility, target acquisition, battlefield survivability and medical care. Improvements in such technologies as electronics and night vision have greatly increased the individual soldier's sphere of battlefield influence. Other by-products of this technological change include increased information flow during continuous operations over an extended, integrated, highly lethal battlefield. The Army considers the technology base an indispensable "Corporate Investment" to ensure continued technological superiority of our forces.

The Army's technology base program is dedicated to identifying, maturing and transitioning technologies to achieve our vision of the future Army. The Basic Research (6.1) program exploits science, identifies technological opportunities and maintains a vital link with university and industry research. Our exploratory development (6.2) program evaluates the technical feasibility of advanced concepts and technologies leading to improved warfighting capabilities. Army non-system specific advanced development (6.3A) efforts speed the transition of technology by conducting demonstrations of advanced technology components, subsystems and systems so that we evaluate technical risk and operational promise prior to full scale development. A critical component of the Army's technology base investment strategy is to set the minimum sustained funding for 6.1 and 6.2 programs at 0% real growth beginning in FY90 and pursue a total technology base program (6.1 and 6.2 and 6.3A) goal of 2% of Army Total Obligation Authority (TOA).

This year the Army has taken important initiatives to focus and strengthen the technology base to increase its quality and contribution to future warfighting capability. Our Technology Base Investment Strategy is documented in the Army Technology Base Master Plan (ATBM), which provides top-down guidance and focus to Army Research and Development activities. Major elements include:

oo Meet near, mid and far term warfighting needs.

oo Reduce the lead-time for introducing new technology into our weapons systems.

oo Retain our leadership in high technology.

oo Identify and exploit key emerging technologies.

oo Leverage other Service, other Government agency, industry, academia and international investment.

oo Balance resources among future systems, supporting capabilities, systemic problems and key emerging technologies.

Army modernization must never stop if we are to stay ahead of the threat. Our modernization strategy and plans balance procurement and R&D within budget realities. The Army Aviation Modernization Plan was our first modernization plan followed by the Heavy Force Modernization Plan with others in preparation. The Army Technology Base Master Plan is linked to these plans. A key feature of these plans is that we modernize inside the threat's research, development and acquisition cycle while also keeping our technological options open during the

R&D process. One key to success is our ability to reduce the lead time needed to introduce new technology into our weapon systems. To this end the Army has focused a significant portion of its 6.3A program on Advanced Technology Transition Demonstrators (ATTD). The Army has a successful track record with such technology demonstrators as evidenced by: Fiber Optic Guided Missile (FOG-M); Advanced Technology Demonstrator Engine (ATDE) which led to the T-800 Engine; and Advanced Composite Airframe Program (ACAP) which demonstrated the composite airframe technology for the LHX.

LHX ▶ ADVANCED TECHNOLOGY CONTRIBUTION
ADVANCED TECHNOLOGIES APPLIED
• Advanced Rotor Design
• Advanced Composite Structures
• Fly By Wire/Light Flight Control System
• Drag Reduction
• T800 Engine
• Advanced Mission Equipment
• Integrated/Automated Cockpit
PROJECTED LHX IMPROVEMENTS vs BLACK HAWK/APACHE TECHNOLOGY
• Less Engine Power Required
• Lighter Empty Weight
• Less Mission Fuel Required
• Improvement in Payload/GW Ratios
• Lighter Design Gross Weight

Some of our current ATTDs are listed below:

o Advanced Combat Vehicle - Integrates and demonstrates advanced technologies critical to future tank and other heavy force armored vehicle designs. It includes: advanced gun, fire control and autoloader; advanced integrated propulsion system; hydropneumatics suspension; advanced lightweight track; vehicle electronics and integrated survivability technologies.

o Advanced Field Artillery System - Demonstrates liquid propellant and unicharge gun technologies; advanced gun mount; advanced fire control; and automated ammunition handling.

o Combat Vehicle Command and Control (CVC2) - Demonstrates technologies for automating the "Cockpit" of ground combat vehicles and the networking of vehicles at the individual vehicle, platoon, company and battalion echelons. CVC2 technologies promise to leverage existing vehicle capabilities for modest investment.

o AirLand Battle Management (ALBM) - Uses artificial intelligence techniques for automating the planning and course of action generation functions in the Army Command and Control system. ALBM will provide the battlefield commander with the decisive edge in formulating battle plans and exploits our technological strength in artificial intelligence.

o Air-to-Air Mission Equipment Package/Weapons Demonstrator (AAMD) - Integrates weapon and mission equipment package advanced technologies to provide armored rotorcraft air-to-air superiority while maintaining outstanding air-to-ground capability.

o Day/Night Adverse Weather Pilotage (D/NAPS) - Enhances mission availability, effectiveness, and survivability by providing adverse weather operation through innovative integration of advanced sensors, computing methods, controls, and displays.

o Integrated High Performance Turbine Engine Technology (IHPTET) - A tri-service program, with the objective of providing advanced propulsion technology options for 21st century Army, Navy and Air Force aircraft propulsion needs.

o Stand-off Mine Detection - Remote detection of minefields has a high priority to counter the mine threat posed by Warsaw pact forces. Standoff detection enables better organization, synchronization, and utilization of resources to counter the mine threat as well as increasing survivability.

o Aided Target Recognition (ATR) - Demonstrates the economical fusion of multiple sensor and processor modules in an automated target acquisition suite and pursues commonality between future air and ground applications.

The Army's Technology Base Investment Strategy also emphasizes the pursuit of a set of key emerging technologies offering high pay-off in warfighting capability. These technologies are:

Protection Lethality
Artificial Intelligence
Robotics
Directed Energy
Micro-Electronics/Photonics/Acoustic Devices
Advanced Materials/Material Processing
Advanced Signal Processing and Computing
Advanced Propulsion
Power Generation/Storage/Conditioning
Space Technology
Low Observables
Biotechnology

In an age of increasing technological opportunities and constrained resources, leveraging of the Army's technology base efforts is a necessity.

Approximately one fourth of the technology base is dedicated to tri-service or DoD commitments for which the Army is the sole financial contributor. An example of this is the development of small arms, 40MM and below. Also, the Army is the principal contributor of technology base work for rotorcraft technology for DoD. In addition, much of the Army's technology base funding is linked to joint funding agreements with NATO and other friendly nations, to other services in areas such as crew member-machine interface, and to joint programs with the Defense Advanced Research Projects Agency (DARPA).



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In addition to joint service programs and cooperative agreements with other services and agencies, the Army is increasingly relying upon industry and academia as a means of increasing its return on investment. A number of mechanisms and programs are available to increase sharing efforts with industry, such as the Small Business Innovative Research (SBIR) and industry IR&D programs. With respect to academia, Army support often yields more than the results of individual research efforts. In many instances it leads to well-supported long-term commitments that provide the Army with the educational assets needed to train both its civilian and military technical personnel of the future. The University Research Initiative (URI) and Army "Centers of Excellence" are valuable sources of information and perspective that are critical to planning long-term technological thrusts.

The underlying strength of the Army's technology base rests in its people and their creativeness. With proper consistent top-down guidance, and a stable program, the professionals who make up the Army's technology base team will ensure our Army maintains its qualitative edge.

# BINARY CHEMICAL WEAPONS MODERNIZATION AND NUCLEAR, BIOLOGICAL AND CHEMICAL (NBC) DEFENSE

Binary chemical weapons modernization and NBC defense impacts across the entire spectrum of the battlefield. The Army's defense posture and recent improvements in our total military readiness could be jeopardized by a single factor - the lack of a credible chemical deterrent.

Our policy with respect to chemical warfare is based on three principles. First, we renounce the first use of chemical weapons. Second, we are continuing to attempt to negotiate a comprehensive, verifiable treaty to ban weapons. Finally, in the absence of a ban on chemical weapons, our program is formulated to deter use by convincing an adversary that his forces will suffer unacceptable consequences if he initiates chemical warfare. To implement this program, we must continue to support a strong chemical deterrent which consists of a credible retaliatory capability and an adequate NBC defense capability.

While continuing to seek a verifiable worldwide ban of chemical weapons, we recognize the current need to maintain the capability for a credible deterrent as an Arms Control position of strength. We have a paramount need to modernize our chemical retaliatory capability. The current stockpile is old and the majority of agent is in bulk storage and of no use.

*Binary Chemical Weapons Modernization*

The modernization program provides three types of binary munitions: binary chemical warhead for the Multiple Launch Rocket System (BCW MLRS); M687 155MM GB-2 projectile; and the BIGEYE bomb (to be fielded by the Air Force and Navy in the early 1990's). The binary concept is a process by which a lethal chemical agent is formed from nonlethal components by means of a chemical reaction during flight of the weapon to a target. Significant advantages over current conventional chemical munitions are achieved in safety, transportation, production, storage, handling and final disposal.

The 155mm GB-2 projectile will provide a nonpersistent nerve agent to influence the close battle. The BCW MLRS, with a semipersistent agent, will provide an intermediate range retaliatory capability beyond the 155mm range. The agent in the BCW MLRS produces both a liquid and vapor hazard on the target that can last for several hours.

*Nuclear, Biological and Chemical (NBC) Defense*

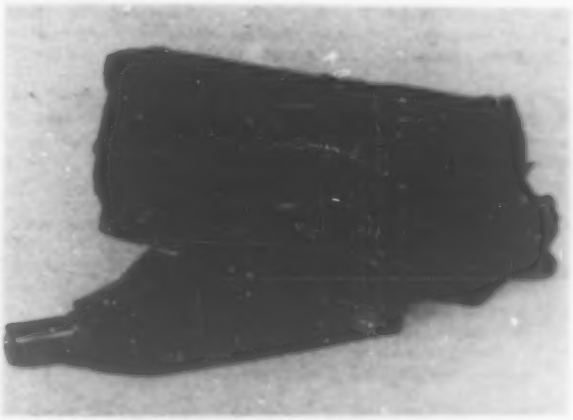
The NBC defense program is a key element of a credible deterrent. The program supports the fundamentals of NBC defense doctrine: contamination avoidance, protection, and decontamination. In the 1990's we begin to procure key NBC systems. The NBC reconnaissance system (NBCRS) will fill the urgent operational need to execute contamination avoidance throughout the depth of the battlefield.

New protective masks and lightweight protective garments being fielded in the 1990's will reduce the burden of operating in a contaminated environment. A collective protection system for corps hospitals will provide protection from contamination and allow medical personnel to care for casualties in a safe environment.

Decontamination capability is seriously lacking. The 1990's will produce new and more effective decontamination equipment that will reduce the current time consuming and labor intensive process. Key equipment includes the M17 lightweight decon system and a non-aqueous equipment decon system.

***M40 Protective Mask***

The M40 Protective Mask is an individual respiratory protection device that shields face, eyes, and lungs from field concentrations of chemical/biological agents, riot control agents, toxins, and smoke. The M40 is designed to replace the M9 and M17 series protective masks. Basis of issue of the mask is one per individual soldier. Fielding will occur during FY89 with priority of issue being to units with a peacetime chemical handling mission. The filter canister is NATO compatible, rapidly replaceable and can be mounted on either side of the mask as desired by the wearer. The mask affords better protection and is more comfortable than the M17 series mask.



***Chemical Agent Monitor (CAM)***

The Chemical Agent Monitor (CAM) is a hand-held, soldier operated device for monitoring chemical agent contamination on personnel and equipment. The monitor will detect and display the relative concentrations of contamination of either nerve or blister agent. The CAM is not a replacement for the currently fielded M8A1 Chemical Agent Alarm, rather it is strictly a post attack survey/monitor instrument. The CAM can be used to determine when chemical protective clothing can be removed, what supplies and equipment present a chemical hazard, the effectiveness of decontamination, where clean areas are, the contamination/cleanliness status of casualties entering medical treatment facilities, and whether collective protection enclosures have been breached by chemical agents. When the CAM detects the presence of a chemical agent vapor, a visual display will indicate the type and the relative concentration of agent. The CAM will be fielded in late FY89. Distribution is two per company or equivalent sized unit (plus special distribution for chemical and medical units).

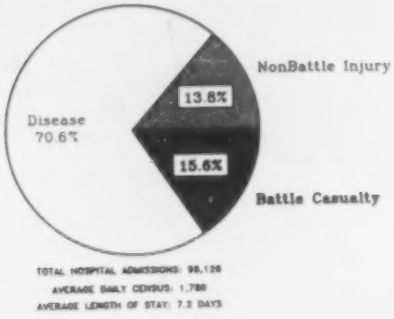
# MEDICAL RESEARCH

The soldier is the most vulnerable and critical component in the array of battlefield "systems." The Army medical research and development program is geared to address performance degradation factors that could make this human system inoperable or cause it to operate at reduced efficiency due to physical, psychological, or disease-related stresses in a variety of climates and hostile environments, both in peacetime and during periods of conflict.

Chemical weapons continue to represent a major threat against U.S. forces. Recent events have dramatically demonstrated that warring nations will use every weapon in their inventories, including chemical weapons, to persevere in a conflict. During FY90 a resin-based skin decontaminating kit (SDK) will be fielded. Unlike the previous generation skin decontamination kit, the new resin-based SDK is non toxic, non-irritating and is effective against multiple threat agents. Because the SDK is non-corrosive, it can be used in training and familiarization by U.S. forces so confidence can be assured. Also in FY90, a Medical Aerosolized Nerve Agent Antidote (MANAA) will be fielded. This is an aerosolized formulation of atropine which will be issued to medical personnel to treat nerve agent casualties as a follow-on to the autoinjector. The MANAA contains the equivalent of 40, 2-milligram autoinjectors of atropine which significantly decreases the logistical burden of providing sufficient atropine far forward to adequately manage nerve agent casualties. In FY90, the Medical Chemical Defense RDTE program will transition a new, broad spectrum pretreatment/antidote for nerve agent poisoning from Tech Base to development. Furthermore, information that has been collected using performance assessment methods will be available to provide an added level of accuracy to doctrine and the operations of combat aviators.

The potential numbers of biological threat agents has increased exponentially due to the recent advances in biotechnology. Through recombinant DNA technology it is now possible for our adversaries to isolate, chemically define and synthesize biotoxins which are highly potent but which exist only in nature in minute quantities. These include such substances as marine toxins or snake venoms. In addition, recombinant DNA technology may be used to alter microorganisms so as to enhance their suitability as biological warfare agents. To address this increasing threat, the medical biological defense program has been reevaluated to emphasize new approaches to the increasing threat. A safe, effective vaccine that will protect against Rift Valley Fever Virus, an acute febrile illness of Sub-Sahara Africa which can jeopardize the mission by temporarily incapacitating or occasionally causing death, will be fielded in FY90. This vaccine will protect against both the natural transmission and threat biological warfare use of this virus. Recently, a contract was signed to make an Anthrax vaccine available by FY91 for contingency forces. Microencapsulation technology will be used to develop/evaluate organ and tissue specific vaccines and drug delivery systems to protect U.S. forces.

COMPARISON OF CAUSES OF ADMISSIONS OF
ACTIVE-DUTY PATIENTS (VIETNAM 1969)




Naturally occurring infectious diseases caused more hospital admissions in U.S. forces during World War II, Korea and Vietnam than battle and nonbattle injuries combined. This includes such diseases as malaria, dysentery and dengue. A number of significant developments related to the diagnosis, prevention and treatment of these diseases have recently been made by U.S. military scientists. In FY90 an antiviral drug, Ribavirin, will be fielded to treat life threatening viral diseases such as the hemorrhagic fevers. To date no other therapeutic products exist for this group of viruses which are endemic in areas of strategic interest. Also in FY90, a vaccine against Japanese Encephalitis Virus will be fielded. This vaccine has already been used under approved human use protocols to protect U.S. forces during field exercises in Thailand and Korea. A new generation, topical insect/arthropod repellent will be fielded. This repellent provides a user acceptable, operationally practical product that protects U.S. forces against bites from insects/arthropods for up to twelve hours with a single application, thus reducing casualties from insect-transmitted diseases. Furthermore, the U.S. Army Medical Research and Development Command executes the Congressionally mandated, DoD directed Acquired Immune Deficiency Syndrome (AIDS) RDTE program which was established to resolve militarily unique questions concerning manning, mobilization and deployment of U.S. forces.

The intensity of combat and the resulting increased casualty rates in the future will exceed comprehension. The ability to stabilize, evacuate and treat injured personnel will tax the medical and logistical assets of the services. To this end, research is ongoing in several areas to reduce the morbidity and mortality from these causes. In FY90, a new resuscitative fluid, Hypertonic Saline Dextran (HSD) will be fielded. This innovative product will have broad implications on the battlefield in the stabilization and treatment of hemorrhagic shock casualties. Hypertonic Saline Dextran resuscitation provides a more realistic treatment in that it requires only one-twelfth of the previously required volume/weight of fluid (e.g. a reduction of 6.6 pounds) and stabilizes the casualty victim for six to eight hours (an important factor when evacuation is delayed). The development of stroma free hemoglobin and battlefield filmless imaging will continue. Stroma free

hemoglobin when fielded will provided an alternative to whole blood requirements (collection and storage) in a combat scenario. Battlefield filmless imaging will improve and expedite the radiological processes required in casualty care. These products, like HSD, will also reduce the logistical burden for medical supplies and enhance the survival capabilities for U.S. forces. Medical research also includes the development of synthetic, biodegradable implant materials to replace missing facial bone segments that will also accelerate wound healing and simplify final surgical reconstruction.

Many of the normal, daily hazards impacting on the soldier come from sources such as blast overpressure from artillery, combustion fumes from explosions, and radiation from laser, microwave, and radar systems. Army medical research addresses these occupational hazards as well as environmental hazards. Medical research is directed to study the stresses affecting the soldier-operator that are produced by materiel systems, battlefield environments, and environmental extremes. In Combat Health Hazards Assessments RDTE, a study in Training Injury Prevention Strategies will be completed in FY90. Results from this study will be used to make recommendation to U.S Army Training and Doctrine Command on the means by which the incidence of training-induced stress fractures may be reduced without significant impact on conditioning of military personnel. Other accomplishments include the Soldier Safety Monitor System which allows for monitoring up to fifty subjects per system during field exercises; the completion of the non-fragment injury assessment criteria for the Army's Live Fire Testing Program; and the effects of using Remotely Piloted Vehicles for aerial spraying to suppress disease vectoring populations. Emerging technologies in Health Hazards Assessments include Ocular Protection for Wavelength Agile Lasers, a Bioeffects Data Base for the Free Electron Laser, efforts in Downsizing and Lightening the Force while increasing the capabilities and versatility of all medical materiel, and the Utilization of Artificial Intelligence Concepts in the Battalion Aid Station.

Efforts continue to be directed to enhancing the transportability of medical materiel through reduction of weight and size. Combat medical materiel items being developed to reduce the logistical burden and enhance survivability and return to duty include field production of oxygen and medical grade (intravenous) water, a field medical refrigerator, and a heated patient liner for the transportation of casualties in cold environments.

# ARMY RDA SPACE ACTIVITIES

Space has become a fourth dimension for national defense along with land, air and sea. The Army continues to support the long-standing direct receipt of National capabilities to the tactical forces. Space activities offer real time capabilities to see as deep as necessary to help the commander in the deep attack of enemy forces. The Army's space commitment is highlighted by the Army Space Command becoming our newest command in April 1988. This commitment has challenged the Army to pool the appropriate human, material and financial resources in order to create a growing cadre of space experts and to develop space systems that support Army mission requirements. Efforts to consolidate most of the Army space RDA in a single space integration project (in PE 63006A) within the R&D community beginning in FY90 further highlights our commitment. The consolidation of space R&D will give continuity to the Army's space effort and eliminate any duplication of effort. The Strategic Defense Command programs, which account for approximately one-third of the overall Strategic Defense Initiative budget, is covered in the last section of this statement.

## GROUND BASED ASAT SYSTEM

Anti-Satellite (ASAT) weapons and their command and control elements constitute the space forces necessary to execute space control operations. The objective of the Ground Based Anti-Satellite (ASAT) Systems is to ensure access to space. During the next year the Army will establish a Joint Program Office (JPO) for the kinetic energy weapon system. The Navy will provide a Deputy Program Manager. Options for sea and/or land-based versions will be presented to the Defense Acquisition Board at Milestone I for a final concept selection. An initial Cost and Operational Effectiveness Analysis, and a Test and Evaluation Master Plan will be developed along with a life cycle cost estimate for both the kinetic energy weapons system and the surveillance and Battle Management, Command, Control and Communication (BM/C3) portion of the program.

## STRATEGIC DEFENSE

**Strategic Defense**

The Army has been conducting research and development aimed at increasing the capabilities and effectiveness of strategic defense systems for over 30 years. This effort was conducted by evolving Ballistic Missile Defense (BMD) organizations which created an extensive technology base. Thus, when President Reagan called for creation of a defense against nuclear-armed ballistic missiles, the Army was able to lend extensive support to the Strategic Defense Initiative (SDI) by providing ongoing research and early demonstrations of BMD technology. The efforts of the US Army Strategic Defense Command (USASDC) in support of SDIO can be categorized into the five key areas of strategic defense:

o Surveillance, Acquisition, Tracking, and Kill Assessment include radars such as the Ground based Radar (GBR), to provide tracking and identification of incoming enemy warheads. Other projects include a rocket-borne sensor probe, known as the Ground Based Surveillance and Tracking System (GSTS), to provide early warning and tracking, and the Airborne Optical Adjunct (AOA), a testbed for optical and laser tracking technologies.

o Directed Energy Weapons programs explore exotic technologies, such as the Ground Based Laser (GBL), which will demonstrate the feasibility of using lasers to attack hostile objects in space. Other beam devices, such as the Neutral Particle Beam (NPB), hold the promise of being able to distinguish enemy warheads from decoys and other debris through interactive discrimination.

o Kinetic Energy Weapons, which utilize hit to kill technologies, have the ability to acquire, track, and intercept high speed targets. The High Endoatmospheric Interceptor (HEDI) is a high velocity interceptor which will destroy reentry vehicles within the atmosphere, while the Exoatmospheric Reentry-Vehicle Interceptor Subsystem (ERIS) program is designed to intercept enemy weapons outside the atmosphere. Both use non-nuclear kill technology. Advanced research is also ongoing in hypervelocity weapons which use electrothermal and electromagnetic energy to propel projectiles at very high velocities.

o Systems Analysis/Battle Management provides control of the complex, multilayered defense system. The Army is focusing on mid-course and terminal phases of hostile missile flight, and for both continental and theater defense modes. Experiments are being conducted to validate, through simulation, prototype software to collect the necessary sensor data, make timely decisions, and pass instructions to the weapon systems.

o Survivability, Lethality, and Key Technologies investigate methods for enhancing survivability, reducing uncertainties of lethality and vulnerability, evaluating Soviet countermeasures, and developing materials to support system concepts.

Recent program successes have led the Defense Acquisition Board to approve the start of demonstration and validation for a first phase of a strategic defense system. The Army systems included in this initial phase are the ERIS interceptor, the ground-based radar (GBR), the Ground-Based Surveillance and Tracking System (GSTS) sensor probe and the ground portion of the battle management. A full scale development decision is expected by mid-1990.

"Spin-offs" from technology advancements in strategic systems offer the potential to revolutionize tactical capabilities. For example, USASDC is exploiting technologies which can be utilized for Theater Missile Defense (TMD). This is a result of Presidential guidance to expand research on technologies for a defense against ballistic missiles of all ranges that threaten the United States and our allies. Consistent with this guidance, the Army is examining architectures, concepts and systems for theater missile defense against short and medium range ballistic missiles.

TMD concept definition and architecture studies are being conducted through cooperative agreements with our allies. These studies include definition of system specifications as well as operational and organizational concepts to include an analysis of the post-INF (Intermediate Nuclear Forces) treaty environment.

The Extended Air Defense Test Bed (EADTB) is an Army program that will provide the facilities, hardware, and software necessary to conduct simulations and to support analyses of TMD issues. The EADTB concept features testbed nodes at each of several participating locations both in Europe and in CONUS.

The Army is also conducting extensive research into systems capable of providing active defense against the TMD threat. The Extended Range Interceptor (ERINT-1) program will develop and demonstrate a prototype missile and fire control system. In addition, the Army in conjunction with SDIO has entered into an agreement to develop and demonstrate Israeli ARROW missile technology against surrogate TMD targets. The Invite, Show, and Test (IST) program will evaluate and test US and Allied systems, subsystems and components in order to identify available technologies which may contribute to TMD. Eight IST contracts have been awarded (two each in seekers, radars, sensors, and interceptors).

An additional integral part of the US Army Strategic Defense Command mission is the management of US Army Kwajalein Atoll (USAKA) as a National range for strategic defensive and offensive systems for all services.

Through all of these research and development efforts the Army continues to fulfill a vital role in the development of an effective missile defense for the United States and our allies.

# SOLDIER SUPPORT AND SURVIVABILITY

Soldier Support and Survivability encompasses the development of, and application of technology designed specifically to improve the battlefield efficiency of our soldiers. Development efforts include new food items and food service equipment that meet high nutrition requirements while reducing the numbers of food service personnel, food procurement costs, and total food logistics support requirements. Individual clothing and equipment items lighten the individual soldier's load and provide improved protection against environmental extremes, nuclear, chemical, biological agents, and ballistic/laser hazards.

Currently there are 30 clothing and individual equipment R&D projects ongoing which have been approved by the Chief of Staff, Army. Projects include laser/ballistic eye protection, self contained chemical uniform flechette ballistic vest, aircrew battledress uniform, aircrew cold weather uniform, snow and ice traversing equipment, and equipment airdrop containers. Also, 34 product improvements to fielded items are being worked. These include improved aircrew/CVC cooling vest, light duty leather glove, vapor barrier boot, extra large PASGT helmet, chemical/biological glove, combat boot sock, and wet weather parka/trousers.

During 1989, 11 items are expected to be approved and type classified. These will include the 40MM grenade vest aircrew NBC uniform, extreme cold weather canteen, aircrew flight uniform, interim self contained chemical uniform, enhanced SPH4 aviator helmet, gross chemical liquid protection overgarment, laser/ballistic eye protection, aviator survival vest, snow/ice traversing equipment and sleeping bag pad.

# TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

The TMDE systems provide equipment, state-of-the-art technologies, and support for the testing and diagnostics, of major fielded weapon systems, e.g., Hawk, Multiple Launch Rocket System (MLRS), AH-64 Apache, CH-47D Chinook, Joint Tactical Fusion, Forward Area Air Defense System (FAAD), Abrams tank and the Bradley Fighting Vehicle. The introduction of new TMDE and sustainment of current TMDE is essential for the success of the Army's Force Modernization Program and critical for the readiness and sustainment of presently fielded weapons systems.

The FY90 funds will continue the procurement and development of test measurement equipment, calibration standards hardware, accessories, intermediate forward test equipment (IFTE), Commercially Equivalent Equipment (CEE), Contact Test Set (CTS), and other automatic test equipment (ATE). The first option to the low rate initial production (LRIP) for IFTE will be awarded during the 1st Qtr, FY90.

**IFTE BASE SHOP TEST STATION (HAWK)**

# CONCLUSION

The FY90 budget request represents a balanced program to equip the Army. Our broad-based modernization program, the greatest in peacetime history, is allowing us to provide our soldiers with the quality equipment they need to maintain deterrence and prevail in case of war. As the Chief of Staff of the Army has noted, there is no substitute for the presence of forces on the ground as our nation's clearest symbol of resolve. .

We must buy and allocate our new equipment with sound business sense and optimum military rationale. Our major concern is that further reductions and economic instability will erode our ability to achieve that goal. It is a business axiom that it is futile to try to merely catch up to a competitor—you must leap ahead. Our present major procurement programs have achieved this quantum jump in performance capability. As our Army prepares to move into the next decade, our RDA goal is to continue that trend. The main determinant in our ability to achieve a successful transition into the 1990's is adequate and stable funding. Accordingly, we need the continuing strong support of Congress.

# FY90 BUDGET

## AIRCRAFT PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **AIRCRAFT** | | | |
| **FIXED WING** | | | | |
| A11500 | GRISLY HUNTER | 0.0 | 9.9 | 9.9 |
| A02005 | RC-12H/K RECON AIRPLANE | 67.4 | 52.7 | 106.7 |
| **ROTARY WING** | | | | |
| A03407 | MH-60K (SOF AIRCRAFT) | 0.0 | 71.3 | 68.5 |
| AA0007 | AH-64 ATTACK HELICOPTER (APACHE) | 856.1 | 736.1 | 688.9 |
| A0007 | AH-64 ATTACK HELICOPTER (ADV PROC) | 76.0 | 90.0 | 80.0 |
| AA0005 | UH-60A BLACK HAWK (MYP) | 225.1 | 206.1 | 221.6 |
| AA0005 | UH-60A BLACK HAWK (MYP) ADV PROC | 205.6 | 180.3 | 191.0 |
| | **MODIFICATION** | | | |
| AZ3530 | OV-1 MOHAWK SURVEILLANCE AIRPLANE | 6.2 | 15.2 | 36.9 |
| AZ3530 | OV-1 MOHAWK SURVEILLANCE AIRPLANE (AP) | 0.0 | 0.0 | 0.0 |
| AZ2000 | RC-12D UPGRADE | 31.9 | 43.1 | 34.3 |
| AZ2900 | AIRPLANES, RECON, RU-21 | 7.5 | 1.5 | 9.8 |
| AA0150 | AH-1S ATTACK HELICOPTER (COBRA-TOW) | 29.3 | 5.9 | 4.4 |
| AA6605 | AH-64 MODS | 6.3 | 38.1 | 77.1 |
| AA0250 | CH-47 CARGO HELICOPTER MODS (MYP) | 161.9 | 200.2 | 194.9 |
| AA0250 | CH-47 CARGO HELICOPTER MODS (AP) | 84.4 | 104.3 | 48.9 |
| AA0400 | OH-58 OBSERVATION HELICOPTER (KIOWA) | 17.4 | 28.2 | 26.1 |
| AA0600 | UH-1 UTILITY HELICOPTER (IROQUOIS) | 0.0 | 9.6 | 24.0 |
| AA0490 | UH-60 BLACKHAWK MODS | 23.4 | 41.0 | 69.0 |
| AZ2200 | ARMY HELO IMPROVEMENT PROGRAM (AHIP) | 168.6 | 241.1 | 267.8 |
| AZ2200 | ARMY HELO IMP PGM (AHIP) ADV PROC | 34.0 | 35.3 | 36.5 |
| AA0700 | AIRBORNE AVIONICS | 2.7 | 0.0 | 0.0 |
| AA0720 | ASE MODIFICATIONS CLOSE COMBAT | 25.0 | 7.1 | 12.9 |
| AZ3405 | ACFT 9WW | 24.0 | 19.7 | 18.6 |
| AZ3407 | SOF AIRCRAFT MODIFICATIONS | 70.5 | 212.5 | 317.0 |
| AZ3407 | SOF AIRCRAFT MODIFICATIONS (AP-CY) | 50.0 | 127.4 | 0.0 |
| | **SPARES AND REPAIR PARTS** | | | |
| AA0950 | SPARE PARTS (AA0950) | 552.2 | 576.1 | 564.9 |
| | **SUPPORT EQUIPMENT AND FACILITIES** | | | |
| AZ3504 | AIRCRAFT SURVIVABILITY EQUIPMENT | 65.8 | 98.8 | 109.2 |
| AZ3000 | AVIONICS SUPPORT EQUIPMENT | 24.2 | 23.8 | 25.1 |
| AZ3100 | COMMON GROUND EQUIPMENT | 32.3 | 46.3 | 75.8 |
| AA0050 | AIR TRAFFIC CONTROL | 0.0 | 7.8 | 8.3 |
| AZ3300 | INDUSTRIAL FACILITIES | 21.0 | 23.0 | 26.5 |
| AZ3800 | SYNTHETIC FLIGHT TRAINING SYSTEMS | 0.0 | 10.0 | 9.9 |
| AZ5800 | AVIATION NON SYSTEM TRAINING DEVICES | 0.0 | 0.0 | 7.5 |
| A50100 | WAR CONSUMABLES | 3.1 | 4.3 | 4.4 |
| | TOTAL AIRCRAFT APPROPRIATION | 2871.8 | 3267.5 | 3377.3 |

FY90 MISSILE PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **OTHER MISSILES** | | | |
| | **SURFACE-TO-AIR MISSILE SYSTEM** | | | |
| C22100 | CHAPARRAL | 56.7 | 30.8 | 25.7 |
| H03100 | NON-LINE OFSIGHT MSL (AP)(CY) | 0.0 | 32.5 | 54.3 |
| H01700 | ADS HVY MSL SYSTEM (CURRENT YEAR) | 84.7 | 351.6 | 338.1 |
| H01700 | ADS HVY MSL SYSTEM (AP-CY) | 23.8 | 51.6 | 54.8 |
| C25400 | HAWK MISSILE (MYP) | 0.0 | 55.4 | 48.5 |
| CA0275 | OTHER MISSLE SUPPORT | 4.5 | 1.0 | 4.7 |
| C49100 | PATRIOT (MYP) | 777.6 | 924.5 | 859.9 |
| C49100 | PATRIOT (MYP) ADV PROC | 37.4 | 0.0 | 0.0 |
| C18500 | STINGER (MYP) | 241.3 | 187.5 | 258.8 |
| C18500 | STINGER (MYP) ADV PROC | 0.0 | 0.0 | 21.3 |
| C16000 | LINE OF SIGHT REAR FIRE UNIT (LOS-R) | 91.8 | 115.8 | 110.1 |
| C16000 | LINE OF SIGHT REAR FIRE UNIT(LOS-R) (AD)(CY) | 25.7 | | |
| | **AIR-TO-SURFACE MISSILE SYSTEM** | | | |
| C70000 | LASER HELLFIRE SYSTEM | 204.7 | 138.3 | 137.9 |
| | **ANTI-TANK/ASSAULT MISSILE SYSTEM** | | | |
| C59300 | TOW 2 SUMMARY | 143.1 | 114.7 | 168.7 |
| C67600 | MULTIPLE LAUNCH ROCKET SYSTEM (MYP) | 399.9 | 251.4 | 250.1 |
| C67600 | MULTIPLE LAUNCH ROCKET SYSTEM ADV PRO | 20.8 | 63.4 | 66.0 |
| C98510 | ARMY TACTICAL MISSILE SYSTEM | 66.4 | 133.3 | 184.0 |
| C98510 | ARMY TACTICAL MISSILE SYS (ADV PROC) | 4.3 | 7.6 | 4.9 |
| | **MODIFICATIONS** | | | |
| C50700 | PATRIOT MODS | 40.2 | 19.4 | 18.4 |
| C24200 | CHAPARRAL MODS | 8.1 | 0.0 | 0.0 |
| C35200 | HAWK MODS | 27.6 | 28.8 | 32.8 |
| C61700 | TOW MODS | 33.8 | 59.3 | 54.3 |
| C57300 | DRAGON MODS | 17.3 | 0.0 | 0.0 |
| C76200 | LANCE MODIFICATIONS | 15.4 | 0.0 | 0.0 |
| C92800 | PERSHING MODIFICATIONS | 1.0 | 0.0 | 0.0 |
| CE8000 | TRACTOR RIG | 0.0 | 2.6 | 7.8 |
| C67500 | MLRS MODS | 32.9 | 28.6 | 27.3 |
| C54000 | AN/TSQ-73 MODS | 1.3 | 0.0 | 0.0 |
| | **SPARES AND REPAIR PARTS** | | | |
| CA0250 | SPARES AND REPAIR PARTS | 224.4 | 263.9 | 147.8 |

FY90 MISSILE PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | SUPPORT EQUIPMENT AND FACILITIES | | | |
| C93000 | AIR DEFENSE TARGETS | 21.9 | 33.3 | 33.1 |
| CL2000 | ITEMS LESS THAN $2.0M (MISSILES) | 2.1 | 2.2 | 3.0 |
| CA0100 | PRODUCTION BASE SUPPORT | 9.0 | 10.6 | 6.9 |
| | TOTAL SUPPORT EQUIPMENT AND FACILITIES | 33.1 | 46.1 | 43.0 |
| | TOTAL MISSILE PROCUREMENT, ARMY | 2592.0 | 2907.9 | 3032.6 |

FY90 PROCUREMENT WEAPON TRACKED COMBAT VEHICLES, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **TRACKED COMBAT VEHICLES** | | | |
| | **TRACKED COMBAT VEHICLES** | | | |
| G80702 | BRADLEY FIGHTING VEHICLES (MYP) | 644.1 | 576.4 | 648.3 |
| G80702 | BRADLEY FIGHTING VEH (MYP) ADV PROC | 33.0 | 29.5 | 38.9 |
| G20900 | BRADLEY (BFVS) TRAINING DEVICES | 0.0 | 12.3 | 0.0 |
| GZ2500 | BRADLEY (BFVS) TRAINING DEVICES (MOD) | 1.0 | 0.0 | 0.0 |
| G82500 | REC VEHICLE M88A1 | 78.4 | 0.0 | 108.2 |
| G82500 | REC VEHICLE M88A1..ADV PROCUREMENT | 22.3 | 0.0 | 0.0 |
| G82916 | ABRAMS TANK SERIES ROLL (MYP) | 1126.0 | 1033.7 | 811.3 |
| G82916 | ABRAMS TANK SERIES ROLL (MYP) ADV PRO | 246.9 | 245.0 | 368.3 |
| GB1300 | M1 SERIES TANK TRAINING DEVICES | 0.0 | 12.9 | 14.5 |
| | **MODIFICATION OF TRACKED COMBAT VEHICLES** | | | |
| GB1930 | CARRIER, MOD | 32.7 | 0.0 | 0.0 |
| GZ2400 | BFVS SERIES0512 (MOD) | 45.0 | 84.1 | 109.3 |
| GA0400 | HOWITZER, MED SP FT 155mm M109 (MOD) | 25.5 | 75.5 | 179.6 |
| GA0700 | TANK, M1 SERIES (MOD) | 0.0 | 42.3 | 142.0 |
| GZ3405 | 9WW | 0.6 | 0.5 | 0.5 |
| GA9003 | HOST NATION SUPPORT | 13.0 | 54.0 | 0.0 |
| | **SUPPORT EQUIPMENT AND FACILITIES** | | | |
| GA0150 | SPARES AND REPAIR PARTS (TCV-WTCV) | 339.5 | 325.0 | 380.5 |
| GL3100 | ITEMS LESS THAN $2.0M (TCV-WTCV) | 2.7 | 1.7 | 0.9 |
| GA0050 | PRODUCTION BASE SUPPORT (TCV-WTCV) | 28.7 | 55.4 | 59.6 |
| GA2449 | REGIONAL MAINT TRAIN SITES-EQUIP | 16.2 | 6.4 | 10.0 |
| | **WEAPONS AND OTHER COMBAT VEHICLES** | | | |
| G01300 | HOWITZER, LIGHT, TOWED, 105MM, L119 | 30.5 | 24.6 | 25.7 |
| G11101 | MACHINE GUN, 7.62mm, M60 | 0.0 | 3.0 | 3.0 |
| G12901 | SQUAD AUTOMATIC WEAPON (SAW) 5.56MM | 11.0 | 8.7 | 9.1 |
| GA0510 | SOF WEAPONS | 0.0 | 1.9 | 1.9 |
| G13400 | GRENADE LAUNCHER, AUTO, 40MM, MK19-3 | 12.0 | 19.7 | 19.9 |
| G71100 | LAUNCHER, SMOKE GRENADE | 1.6 | 1.6 | 1.7 |
| G03000 | MORTAR, 120MM | 5.0 | 10.9 | 11.9 |
| G14900 | M16 RIFLE | 22.3 | 14.2 | 14.3 |

FY90 PROCUREMENT WEAPON TRACKED COMBAT VEHICLES, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| G04200 | SNIPER WEAPON SYSTEM | 2.2 | 3.8 | 0.0 |
| G15300 | PERSONAL DEFENSE WEAPON, 9MM | 7.0 | 7.5 | 7.8 |
| G21100 | VEH RAPID FIRE WPN SYS-BUSHMAST(MYP) | 29.5 | 18.7 | 20.6 |
| G21100 | VEH RAPID FIRE-BUSHMASTER ADV PROC | 0.4 | 0.0 | 2.0 |
| MODIFICATION OF WEAPONS AND OTHER COMBAT | | | | |
| GZ2800 | M16A1 RIFLE MODS | 1.8 | 4.0 | 4.4 |
| GC0925 | MODIFICATIONS UNDER $2.0M (WOCV-WTCV) | 4.5 | 0.5 | 0.5 |
| SUPPORT EQUIPMENT AND FACILITIES | | | | |
| GC0150 | SPARES AND REPAIR PARTS (WOCV-WTCV) | 26.4 | 27.0 | 14.3 |
| GL3200 | ITEMS LESS THAN $2.0M (WOCV-WTCV) | 4.2 | 1.0 | 1.9 |
| GC0050 | PRODUCTION BASE SUPPORT (WOCV-WTCV) | 9.3 | 14.1 | 19.3 |
| | TOTAL WEAPON TRACKED COMBAT VEHICLES | 2820.3 | 2745.0 | 3002.1 |

FY90 PROCUREMENT AMMUNITION, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **AMMUNITION** | | | |
| **ATOMIC MATERIEL** | | | | |
| EA0050 | NUCLEAR WEAPONS SUPPORT MATERIEL | 8.9 | 6.5 | 6.1 |
| **CONTROLLED ITEMS** | | | | |
| E00700 | CTG, 5.56MM, ALL TYPES | 78.2 | 41.7 | 56.9 |
| E00701 | CTG, 5.56MM, BALL M193 | | | |
| E00702 | CTG, 5.56MM, TRACER | | | |
| E00703 | CTG, 5.56MM, TRACER CLIP | | | |
| E01100 | CTG, 5.56MM, BLANK M200 | | | |
| E01101 | CTG, 5.56MM, BLK M200, LKD F/SAW | | | |
| E04600 | CTG, 5.56MM, 4 BALL M855/1 TRCRM856LKD | | | |
| E04601 | CTG, 5.56MM, BALL M16-A2 | | | |
| E75500 | CTG, 5.56MM, PLASTIC-M862 | | | |
| E04602 | CTG, 5.56MM, TRACER M16-A2 | | | |
| E02000 | CTG, 7.62MM, ALL TYPES | 51.8 | 18.8 | 21.6 |
| E02002 | CTG, 7.62MM, 4 BALL MBO/1 TRCR M62 LK | | | |
| E02003 | CTG, 7.62MM, BALL M80 LKD/M13 | | | |
| E02007 | CTG, 7.62MM, LKD 4 BALL ITRACER OHF | | | |
| E01902 | CTG, 7.62MM, BLANK M82 LKD/M13 | | | |
| E05700 | CTG, CAL .45, BALL M1911 | 1.3 | | |
| E07000 | CTG, CAL .50, PLASTIC LKD4 BALL/ 1 TRCR | 3.0 | | |
| E07100 | CTG, CAL 50, BALL LKD | 0.0 | 1.4 | 2.0 |
| E07304 | CTG, CAL 50 BLANK T928 W/M9 LK | 0.2 | 0.0 | 0.0 |
| E08904 | CTG, 20MM,LKDTP-T M220 SER MLB M14A2 | 6.3 | 15.0 | 15.0 |
| E08902 | CTG, 20MM, LKD 4 TP M55A2/1TP-T M220 | 2.9 | 0.0 | 3.1 |
| E08201 | CTG, 25MM, HEI-T M792 W/F | 0.0 | 0.0 | 9.6 |
| E08203 | CTG, 25MM, TPT LKD M793 MLB M28 | 10.2 | 0.0 | 0.0 |
| E08204 | CTG, 25MM, AP TRNG, M910 | 45.2 | 14.4 | 30.6 |
| E08210 | CTG, 25MM, APFSDS-T, M919 | 0.0 | 9.1 | 28.3 |
| E10100 | CTG, 30MM, LKD TP M788 | 6.0 | 10.0 | 8.8 |
| ER8001 | CTG, 40MM, ALL TYPES | 8.4 | 46.9 | 25.5 |
| E11801 | CTG, 40MM, HEDP M430 | | | |
| E71100 | CTG, 40MM, TP F/MK19 | | | |
| E13300 | CTG, 40MM, GREEN STAR PARACHUTE | | | |
| E74200 | CTG, 40MM, PRAC M781 | | | |
| E12100 | CTG, 40MM, WHITE STAR CLUSTER M585 | | | |
| E12400 | CTG, 40MM, RED STAR, PARACHUTE | | | |
| E13201 | CTG, 40MM, CS M651 | | | |
| E72000 | CTG, MORTAR, COMM, 1/10 PRAC M840 | 0.0 | 6.4 | 5.0 |
| E70500 | CTG, 60MM, SMOKE WPLWCMS M722 | 4.1 | 3.6 | 3.9 |
| E67303 | CTG, 60MM, HE M720W/M734 MOF | 0.0 | 12.7 | 0.0 |

FY90 PROCUREMENT AMMUNTION, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| E19800 | CTG, 81mm: 1/10 RNG, PRAC, XM880 | 4.5 | 0.0 | 0.0 |
| E25100 | CTG, 4.2-IN HE M329A2 W/O FUZE | 15.0 | 11.3 | 0.0 |
| E25200 | CTG, 4.2 IN MORTAR ILLUMINATING | 18.7 | 0.0 | 0.0 |
| E25501 | CTG, 120MM, HE, XM934 | 6.8 | 0.0 | 21.4 |
| E25502 | CTG, 120MM,HE W/PD FUZE | 14.6 | 0.0 | 22.4 |
| E25504 | CTG, 120MM, SMOKE, XM929 | 12.1 | 0.0 | 16.7 |
| E71600 | CTG, TANK, 35MM, SUBCAL PRDA | 5.5 | 15.2 | 11.4 |
| E24000 | CTG, 105MM, TP-T, M490A1 | 0.0 | 22.9 | 15.7 |
| E22100 | CTG, 105MM, DS-TP M724A1 | 25.8 | 55.9 | 43.7 |
| E73100 | CTG, 120MM APFSDS-T M829 | 130.6 | 0.0 | 0.0 |
| E73200 | CTG, 120MM HEAT-MP-T, M830(MYP) | 29.5 | 0.0 | 0.0 |
| E73300 | CTG, 120MM TP-T M831 (MYP) | 44.2 | 28.5 | 32.6 |
| E15200 | CTG, ARTY, 75MM, BLANK, M337A1 | 0.0 | 1.8 | 0.0 |
| E53700 | CTG, ARTY, 105MM, HERA, M913 | 0.0 | 15.9 | 21.0 |
| E73400 | CTG, 120MM TPCSDS-T, M865(MYP) | 75.7 | 63.5 | 61.7 |
| E28100 | PROJ, 155MM, HE, ICM M483 | 103.2 | 0.0 | 0.0 |
| E67800 | PROJ, 155MM, SMK, WP, M825 | 4.5 | 0.0 | 0.0 |
| E67200 | PROJ, I55MM, HE, ADAM M731 | 51.5 | 62.1 | 0.0 |
| E67501 | PROJ, 155MM, HE, RAAMS M718 | 22.3 | 0.0 | 0.0 |
| E67502 | PROJ, 155MM, HE RAAMS M741 | 21.2 | 47.4 | 0.0 |
| E68500 | PROJ, 155MM, BASEBLEED, XM864 | 111.7 | 178.7 | 89.7 |
| E69800 | PROJ. 155MM, TRAINING, M804 | 15.7 | 0.0 | 17.7 |
| E27201 | CHARGE, PROPELLING,M155MM GREEN BAG M3 | 0.0 | 11.7 | 0.0 |
| E27303 | CHARGE, PROPELLING,M15SMM,RED BAG M203 | 129.7 | 106.3 | 67.6 |
| E27100 | CHARGE, PROPELLING,M155MM,RED BAG M119 | 29.1 | 0.0 | 0.0 |
| E66600 | PROJ, 8-INCH, HE, RAP, M650 | 37.0 | 0.0 | 0.0 |
| E62208 | FUZE, PD M739/M739A1 | 0.0 | 13.7 | 0.0 |
| E61302 | FUZE, MTSQ M577/M577A1 | 5.6 | 0.0 | 0.0 |
| E61503 | FUZE, MTSQ M582/MS82A1 | 10.3 | 0.0 | 0.0 |
| E76300 | FUZE, ET XM762 | 23.2 | 47.4 | 28.8 |
| E63000 | PRIMER, PERC, M82 | 0.7 | 0.0 | 0.0 |
| EA0800 | TRAINING DEVICE, MINE SYSTEM | 0.2 | 0.1 | 0.2 |
| E40602 | GROUND IMP MINE SCAT SYS AT M75 (MYP) | 5.0 | 0.0 | 0.0 |
| E72194 | CANISTER MINE (VOLCANO) PRACTICE M88 | 2.4 | 0.0 | 1.6 |
| E72195 | CANISTER MINE (VOLCANO) XM87 | 54.6 | 81.0 | 57.4 |
| E76900 | MTR RKT 5 IN MK22 MOD4 | 7.8 | 6.9 | 6.0 |
| E75100 | LINE CHARGE M58A3 (MICLIC) | 35.7 | 9.9 | 7.7 |
| E71200 | MODULAR PACK MINE SYSTEM | 33.1 | 40.6 | 8.8 |
| E55400 | DEMOLITION MUNITIONS & OTHER | 22.4 | 0.0 | 10.5 |

FY90 PROCUREMENT AMMUNITION, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| ER0002 | RANGER, ANTI-ARMOR WPN SYS (SOF) | 0.0 | 3.7 | 6.2 |
| E36100 | LIGHTWEIGHT MULTI-PURPOSE WEAPON | 71.6 | 56.0 | 0.0 |
| E32900 | LIGHT WGT MULTI-PURPOSE SYSTEM TRNR | 3.3 | 3.9 | 3.9 |
| E52200 | ROCKET, HYDRA 70, ILLUM, M257 | 0.0 | 15.6 | 13.0 |
| E37309 | HYDRA 70 RKT HE/RS (M151/M433) | 16.6 | 0.0 | 10.1 |
| E37330 | HYDRA 70 RKT SMOKE M264 | 0.0 | 1.2 | 1.2 |
| E37334 | HYDRA 70 RKT, MPSM PRAC M267 | 0.0 | 3.9 | 6.0 |
| E37335 | HYDRA 70 RKDT, HE/PD(M151/M423/MK66) | 0.0 | 8.8 | 8.8 |
| E37337 | HYDRA 70 ROCKET0512 XM274 SIG PRACTICE | 44.3 | 51.2 | 46.4 |
| E28900 | CTG, 165MM, COMB ENG VEH, 7P | 0.0 | 8.1 | 0.0 |
| E57200 | LINEAR SHAPED CHARGE | 2.8 | 0.0 | 0.0 |
| E57300 | TIME DELAY FIRING DEVICE (SOF) | 0.0 | 0.0 | 2.0 |
| E34000 | GRENADE, HAND, ALL TYPES | 6.9 | 12.6 | 3.0 |
| E46900 | SIGNALS, ALL TYPES | 1.2 | 5.0 | 8.6 |
| E51200 | SIMULATORS, ALL TYPES | 4.1 | 5.3 | 7.7 |
| MISCELLANEOUS | | | | |
| EB0016 | AMMO COMPONENTS/SUPPORT, ALL TYPES | 22.7 | 25.6 | 21.7 |
| E77000 | CAD/PAD | 6.8 | 7.2 | 7.8 |
| EA0055 | ITEMS LESS THAN $2.0m (MISC-AMMO) | 9.0 | 7.1 | 6.3 |
| E76700 | EOD EXPLOSIVE ITEMS | 0.0 | 2.3 | 1.4 |
| EA0650 | SPARES AND REPAIR PARTS | 2.5 | 9.1 | 0.0 |
| EA0575 | AMMUNITION PECULIAR EQUIPMENT | 6.7 | 7.1 | 5.8 |
| E64500 | NITROGUANIDINE (LB) | 15.8 | 22.8 | 28.9 |
| EA8000 | AMMO 9WW/ELT | 2.8 | 2.0 | 2.0 |
| EA8200 | HOST NATION SUPPORT | 29.1 | 18.2 | 17.9 |
| | AMMUNITION PRODUCTION BASE SUPPORT | | | |
| PRODUCTION BASE SUPPORT | | | | |
| EP1000 | PROVISION OF INDUSTRIAL FACILITIES | 164.2 | 125.3 | 181.6 |
| EA0054 | COMPONENTS FOR PROVE-OUT | 14.3 | 7.0 | 12.6 |
| EP2000 | LAYAWAY OF INDUSTRIAL FACILITIES | 19.5 | 40.0 | 25.5 |
| EP1300 | RDX FACILITY | 72.3 | | |
| EP4000 | JEFFERSON PROVING GRD MODERNIZATION | 1.0 | 2.0 | 0.0 |
| | TOTAL AMMUNITION PROCUREMENT, ARMY | 2005.2 | 1735.7 | 1542.3 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **TACTICAL AND SUPPORT VEHICLES** | | | |
| **TACTICAL VEHICLES** | | | | |
| DA0100 | TACTICAL TRAILERS/DOLLY SETS | 21.6 | 19.3 | 15.3 |
| D01500 | SEMITRAILER BB/CONT 22 1/2T M871 C/S | 25.7 | 0.0 | 15.4 |
| D01600 | SEMITRAILER BB/CONT 34T M872 C/S | 2.1 | 0.0 | 0.0 |
| D00700 | SEMITRAILER, LOW BED, 40T M870 (C/S) | 6.6 | 0.0 | 0.0 |
| D02300 | SEMITRAILER, TANK, 5000G | 21.4 | 1.2 | 0.0 |
| D02700 | SEMITRAILER, TANK, 7500G, BULKHAUL | 9.8 | 0.0 | 0.0 |
| D03200 | SEMITRAILER,VAN ELEC 6T 2W M373A2 | 6.0 | 0.0 | 0.0 |
| D04900 | SEMITRAILER,VAN ASL, IOT | 0.0 | 0.0 | 11.8 |
| D15500 | FMTV | 0.0 | 0.0 | 78.0 |
| D15400 | HI MOB MULT-PUR WHL VEH(HMMWV)(MYP) | 157.8 | 222.5 | 252.6 |
| D19000 | SMALL UNIT SUPPORT VEHICLE (SUSV) | 8.8 | 28.4 | 29.2 |
| D14000 | TRUCK, 5T, 6X6, ABT (MYP) | 223.7 | 0.0 | 0.0 |
| DV0012 | HEAVY EQUIP TRANSPORTER | 0.0 | 35.0 | 95.8 |
| D16200 | TRUCK, IOT, 8X8, ABT (MYP) | 238.4 | 7.5 | 3.5 |
| D16500 | FHTV | 0.0 | 43.3 | 236.5 |
| D15900 | TRUCK, TRACTOR, LINE HAUL, M915AI | 23.1 | 9.7 | 0.0 |
| DA0925 | MODIFICATION OF IN SERVICE EQUIPMENT | 0.1 | 3.1 | 0.8 |
| G38900 | SHOP EQUIPMENT, AUTO MAINT & REPAIR | 1.9 | 0.0 | 0.0 |
| DL5110 | ITEMS LESS THAN $2.0M (TAC VEH) | 0.6 | 3.5 | 1.5 |
| **NON-TACTICAL VEHICLES** | | | | |
| D23000 | PASSENGER CARRYING VEHICLES | 2.2 | 2.0 | 2.3 |
| D24850 | GENERAL PURPOSE VEHICLES | 1.3 | 5.0 | 6.0 |
| D25500 | TRUCK, CARGO, PICKUP, 4X2 | 0.4 | 0.0 | 0.0 |
| D26300 | TRUCK, CARRYALL | 0.3 | 0.0 | 0.0 |
| D25000 | SPECIAL PURPOSE VEHICLES | 13.8 | 7.7 | 6.7 |
| **SUPPORT EQUIPMENT AND FACILITIES** | | | | |
| DA0350 | SPARES AND REPAIR PARTS (TAC) | 42.5 | 56.9 | 84.1 |
| DA0400 | PRODUCTION BASE SUPPORT (TAC) | 0.7 | 1.4 | 1.0 |
| | **COMMUNICATIONS AND ELECTRONICS** | | | |
| **TELECOM EQUIP - READ CMD COMM** | | | | |
| BB5777 | JCSE EQUIPMENT (USREDCOM) | 42.8 | 2.4 | 4.3 |
| BB2000 | CLASSIFIED PROJECT 9WW | 22.5 | 8.5 | 9.0 |
| BB2001 | TRACTOR SEAT | 0.0 | 0.6 | 1.0 |
| **TELECOM EQUIP- JOINT TACTICAL COMM PR** | | | | |
| BA1010 | TRI-TAC EQUIPMENT | 112.4 | 22.1 | 24.9 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| BB1610 | MOB SUBSCRIBER EQUIP | 991.1 | 984.7 | 345.6 |
| BB1600 | MOD OF,IN-SVC EQ (TRI-TAC) | 23.0 | 0.0 | 0.0 |
| TELECOMM EQUIP-COMBAT SUPPORT COMM | | | | |
| Z16800 | BECS | 11.0 | 33.2 | 31.0 |
| BW0006 | SINCGARS FAMILY | 236.8 | 315.7 | 314.5 |
| BC2200 | SOF MOD RADIOS | 95.9 | 26.5 | 47.9 |
| W18300 | SMALL UNIT TRANSCEIVER | 4.7 | 4.0 | 0.0 |
| W11900 | SMALL UNIT TRANSCEIVER (SOF) | 0.1 | 0.0 | 0.0 |
| BB1550 | MOD OF IN SVC EQUIP (SMC) | 6.3 | 4.2 | 4.3 |
| BZ8250 | SW ASIA/COMM INFRSTRUCTURE | 11.5 | 17.1 | 6.1 |
| BA5210 | ITEMS LESS THAN $2.0M (CSC-C-E) | 2.2 | 0.2 | 0.0 |
| BA5200 | SOF ITEMS UNDER $2.0 MILLION (SCS-C-E) | 1.0 | 0.0 | 0.0 |
| BA8110 | SECURE CONF PROJECT | 0.0 | 2.2 | 1.1 |
| TELECOMM EQUIP-STARCOM NON-DCS | | | | |
| BU3770 | AR TELECOM AUTO PR (ATCAP) | 4.6 | 3.1 | 2.5 |
| BU4160 | C-E FACILITIES/PROJECTS | 2.9 | 2.1 | 3.1 |
| BU4000 | SOUTHCOM C3 UPGRADE | 0.0 | 13.9 | 10.9 |
| BW0020 | SOUTHCOM INTELL MGMT SYS | 0.0 | 1.9 | 2.0 |
| BD3100 | ELECTROMAG COMP PROG (EMCP) | 0.0 | 0.5 | 0.4 |
| LONG-HAUL COM (DCS) | | | | |
| BU0300 | DEFENSE DATA NETWORK (DDN) | 0.0 | 0.6 | 2.6 |
| BU2000 | TRANSMISSION MEDIA EUROPE | 0.0 | 5.1 | 6.9 |
| BU2100 | TRANSMISSION MEDIA (PACOM) | 0.0 | 0.4 | 0.8 |
| BU3610 | WW TECH CON IMP PR (WWTCIP) | 0.0 | 3.0 | 4.0 |
| TELECOM EQUIP-STARCOM-GRD ENVIRON | | | | |
| BB8501 | DIGITAL EQUIPMENT (DSCS) | 7.0 | 5.7 | 8.3 |
| BB8504 | INTERCONNECT FACILITY (DSCS) | 3.0 | 5.6 | 3.1 |
| BA8300 | JAM RESISTANT SECURE COM (JRSC) | 3.0 | 4.9 | 4.9 |
| BB8509 | DSCS OPERATIONS CONTROL SYS (DOCS) | 42.2 | 20.7 | 20.9 |
| BB8416 | MOD IN-SVC EQUIP (DSCS) | 3.3 | 1.9 | 3.6 |
| K28900 | MPK SAT UHF TERM, AN/PSC-3 (SOF) | 1.3 | 0.0 | 0.0 |
| K45900 | VEH SAT UHF TERM, AN/VSC-7 | 0.6 | 0.0 | 0.0 |
| K77200 | ADV MANPACK UHF TERM COMSEC DEVICE (K77200) | 0.0 | 0.0 | 1.5 |
| K23700 | SINGLE CHANNEL OBJ TACT TERM (SCOTT) | 36.3 | 38.6 | 71.8 |
| BB8417 | MOD IN-SVC EQUIP (TAC SAT) | 3.4 | 2.6 | 3.2 |
| W43000 | SINGLE CHANNEL UHF DAMA | 0.0 | 0.0 | 1.4 |
| K49500 | GMF CONTROL | 0.0 | 0.0 | 1.0 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| **TELECOM EQUIP-COMSEC EQUIPMENT** | | | | |
| BA8200 | EUCOM ALTERNATE SPT HQ (ASH) | 0.0 | 5.4 | 0.0 |
| BA8250 | USAREUR C2 PROJECT(TACTICAL CMD&CTRL) | 5.8 | 5.1 | 5.6 |
| **TELECOMM EQUIP-COMSEC EQUIPMENT** | | | | |
| TA0700 | IFF COMSEC | 4.8 | 0.0 | 0.0 |
| TA0500 | TRUNK ENCRYPTION DEVICES (TED) | 6.6 | 10.0 | 7.5 |
| TA0600 | MINTERM KY-99 | 0.0 | 6.2 | 5.8 |
| T68000 | AUTO KEY DC KGX-93/TSEC | 1.0 | 0.0 | 0.0 |
| BZ8950 | SECURE VOICE IMPROVEMENT PRG(COMSEC) | 22.6 | 1.5 | 1.7 |
| T54000 | DED LOOP ENCRYP DEV KG-84 | 8.6 | 11.4 | 10.7 |
| T06400 | COMSEC MODULE, TSEC/KGV-13 | 6.1 | 0.0 | 0.0 |
| T99500 | FREQ MODULE, KGV-10/TSEC | 10.8 | 0.0 | 0.0 |
| T06300 | ADDS COMSEC KOK-13 | 0.0 | 0.1 | 3.0 |
| BL5264 | ITEMS LESS THAN $2.0M (COMSEC) | 3.4 | 6.0 | 6.0 |
| BL5265 | ITEMS UNDER $2.0 MILLION (COMSEC) SOF | 0.2 | 0.0 | 0.0 |
| **TELECOM EQUIP-BASE COMM** | | | | |
| BB8700 | INFO SYS CONUS/WESTERN HEMISPHERE | 14.0 | 18.5 | 11.2 |
| BU4165 | LOCAL AREA NETWORK (LAN) | 0.0 | 0.5 | 4.7 |
| BB8800 | INFORMATION SYSTEMS (EUCOM) | 3.9 | 8.9 | 8.8 |
| BB8900 | INFORMATION SYSTEMS (PACOM) | 7.0 | 1.7 | 3.8 |
| BB1400 | INFO SYS-MCA SUPPORT | 0.0 | 23.3 | 21.8 |
| BQ0100 | PENTAGON TELECOM CTR (PTC) | 0.0 | 1.2 | 3.3 |
| BB7600 | ARMY PRNTG AND BNDG EQUIP | 0.0 | 3.0 | 3.4 |
| **TMDE FOR TELECOMM** | | | | |
| BZ5269 | CALIBRATION SETS EQUIPMENT | 22.0 | 14.4 | 15.4 |
| BZ5270 | TMDE MODERNIZATION | 16.7 | 22.6 | 20.3 |
| **OTHER ELECT SYS/EQUIP-INTELLIGENCE** | | | | |
| BB2050 | 4TH PSYOP GROUP (SOF) | 11.2 | 10.1 | 10.2 |
| V15900 | SINGLE SOURCE PROCESSOR - SIGINT | 4.6 | 0.0 | 0.0 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| BL5278 | ITEMS LESS THAN $2.OM (INT-SPT-C-E) | 1.3 | 5.3 | 4.5 |
| BB6010 | FT DEVENS TRNG SPT | 0.5 | 0.0 | 0.0 |
| | OTHER ELECT SYS/EQUIP-AUTO DATA PROC | | | |
| BD3970 | STARNET/VIABLE | 2.0 | 2.0 | 2.8 |
| BD3950 | AMC INFO PROCESSING EQUIP (IPE) | 13.0 | 20.9 | 15.1 |
| B28600 | ADV FIELD ARTILLERY TACT DATA SYS | 0.0 | 7.4 | 16.4 |
| BU1400 | ARMY DATA DISTRIBUTION SYSTEM-ADDS | 74.1 | 48.8 | 223.3 |
| B28700 | LIGHT TACFIRE | 13.2 | 0.0 | 0.0 |
| BZ9200 | TRADOC AUTOMATION | 0.5 | 5.6 | 2.7 |
| BD3955 | LIFE CYCLE SOFTWARE SUP (LCCS) | 9.2 | 0.5 | 0.5 |
| BE4152 | SUPERCOMPUTERS | 27.3 | 0.0 | 0.0 |
| BE4159 | EUSA-C3I INITIATIVES | 8.6 | 7.2 | 5.4 |
| BE2000 | ACQN INFO MAN | 0.0 | 2.9 | 6.6 |
| BE4161 | HQ AUTOMATION SYSTEMS | 9.2 | 36.7 | 31.4 |
| BE4162 | INFO PROC EQUIP | 0.0 | 8.2 | 8.4 |
| BE4163 | MEDICAL AUTOMATION SYSTEMS | 1.6 | 2.6 | 2.3 |
| BE4164 | PERSONNEL AUTOMATION SYSTEMS | 11.2 | 11.2 | 12.5 |
| BE4165 | TRAINING AUTOMATION SYSTEMS | 0.0 | 1.0 | 0.0 |
| BE4166 | LOGISTICS AUTOMATION SYSTEMS | 7.4 | 15.0 | 7.5 |
| BE4167 | RESERVE COMPONENT AUTOMATION SYSTEMS | 34.5 | 0.0 | 0.0 |
| W34600 | CBT SVE SPT CONTR SYS | 0.0 | 1.0 | 0.3 |
| BZ9851 | FORWARD ENTRY DEVICE | 4.5 | 24.6 | 21.2 |
| BA9300 | MANEUVER CNTRL SYSTEM | 9.6 | 13.9 | 0.0 |
| BE4000 | ARMY RESERVES HQ INFO SYS | 0.0 | 8.0 | 5.3 |
| BZ9350 | CORPS/THEATER ADP SVC CTR (CTASC) | 7.6 | 17.7 | 23.5 |
| W00800 | TACT ARMY CMBT COMPT SY (TACCS) | 23.5 | 24.9 | 21.6 |
| AD5050 | FAADC2 | 0.0 | 0.0 | 52.8 |
| AD5054 | TRACTOR BALL | 0.0 | 1.0 | 4.5 |
| AD5055 | TRACTOR CRASH | 0.0 | 14.6 | 23.0 |
| WK5053 | FAAD GBS | 0.0 | 48.2 | 48.5 |
| BZ8888 | UNIT LEVEL COMPUTER | 0.0 | 14.8 | 11.4 |
| AD5051 | POSITIVE HOSTILE ID | 0.0 | 0.0 | 2.3 |
| BZ8889 | CSS LOG APL AUTO MARK/RD SYM(LOG MAR) | 7.5 | 8.0 | 11.9 |
| BE4100 | WWMCCS INFORMATION SYSTEM (WIS) | 18.2 | 31.9 | 31.9 |
| | AUDIO VISUAL | | | |
| BZ8480 | AFRTS (AUDIO VISUAL) | 5.2 | 5.9 | 6.2 |
| BL5289 | ITEMS LESS THAN $2.OM (A/V C-E) | 5.1 | 2.0 | 2.0 |
| BL5290 | TACTICAL ELEC NEWS GATHERING EQUIP | 1.9 | 0.0 | 0.0 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| **OTHER ELECT SYS/EQUIP-WARFARE** | | | | |
| BZ7327 | MOD IN SVC EQUIP (EW) | 10.8 | 8.4 | 0.0 |
| BL5292 | ITEMS LESS THAN $2.0M (EW-C-E) | 0.9 | 0.0 | 0.0 |
| **OTHER ELECT SYS/EQUIP-TACICAL ELEC** | | | | |
| K02900 | POWER SUPPLY, PP-6224 | 3.2 | 0.0 | 0.0 |
| B92400 | COMPUTER/INDICATOR, CP-696/PD | 6.4 | 6.7 | 6.9 |
| K27800 | LIGHTWEIGHT ARTY MET SYS (LAWS) | 4.0 | 0.0 | 0.0 |
| B53800 | MINI EYESAF LASER INFRD OBS SET AN/PVS-6 | 0.0 | 0.0 | 12.4 |
| BZ7900 | PHYSICAL SECURITY EQUIPMENT | 16.2 | 12.7 | 8.2 |
| M60200 | FACILITY INTRUSION DETECTION SYSTEM | 10.3 | 5.7 | 2.9 |
| KA4300 | NAVSTAR USER EQUIPMENT | 14.7 | 27.0 | 32.8 |
| M75700 | POS/AZIMUTH DETERMINING SYS (PADS) | 15.4 | 0.0 | 0.0 |
| KA3500 | NIGHT VISION GOGGLES | 137.5 | 45.3 | 45.5 |
| K35000 | AIMING LIGHT INFRARED, AN/PAQ-4 | 1.9 | 1.5 | 2.5 |
| K41500 | NIGHT VISION SIGHT INDIV WPN N/PVS-4 | 14.0 | 14.9 | 14.6 |
| B43300 | RADIAC SET AN/VDR-2 | 2.8 | 8.7 | 10.9 |
| BP1002 | IMP-REMBASS (SOF) | 0.0 | 0.0 | 10.1 |
| B47100 | MULTIFUNCTION RADAR TRANSPONDER BEACO | 7.4 | 2.2 | 0.0 |
| KA4200 | ELECTRONIC MAINTENANCE SHOPS | 3.7 | 0.0 | 0.0 |
| BZ7325 | MOD OF IN SVC EQUIP (TAC EL) | 26.6 | 11.2 | 8.3 |
| BL5295 | ITEMS LESS THAN $2.0M (TACT ELEC-C-E) | 6.3 | 1.6 | 0.0 |
| **TMDE FOR TACTICAL ELECTRONICS** | | | | |
| KA4000 | INTERMEDIATE FORWARD TEST EQUIP | 34.8 | 39.7 | 34.2 |
| M87001 | TMDE FOR STE/ICE | 1.8 | 0.0 | 0.0 |
| M87003 | CORE ELEC AUTO TEST (CSTE-X) | 2.7 | 2.0 | 2.0 |
| **OTHER ELECT SYS/EQUIP-SUP EQ AND FAC** | | | | |
| BA9400 | SP/REP PARTS | 321.5 | 317.4 | 313.7 |
| BF5500 | SPECIAL PROGRAMS | 59.3 | 59.9 | 70.6 |
| BB9051 | PR ENH CAP I W PR/QWK RT INV PR | 7.1 | 14.7 | 14.8 |
| BF5400 | PRODUCTION BASE SUPPORT (C-E) | 7.7 | 9.6 | 12.0 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | **OTHER SUPPORT EQUIPMENT** | | | |
| | **CHEMICAL DEFENSIVE EQUIPMENT** | | | |
| MA0030 | MODULAR DECON SYS | 0.0 | 0.0 | 1.6 |
| M67400 | DECONTAMINATE APP PWR DR LT WT XM17 | 5.0 | 0.0 | 8.6 |
| MA5000 | MASK, PROTECTIVE, NBC | 4.5 | 56.0 | 60.6 |
| M99500 | MASK, ACFT | 0.0 | 9.9 | 27.5 |
| S02200 | CHEMICAL AGENT MONITOR | 0.0 | 19.8 | 20.4 |
| M97400 | SIMP COLL PROT EQUIP XM20 | 4.7 | 6.2 | 3.7 |
| SX8001 | COLL PROT EQUIP, NBC TEMPER | 0.0 | 0.0 | 4.4 |
| | **BRIDGING EQUIPMENT** | | | |
| MA2844 | HEAVY ASSAULT BRIDGE | 0.0 | 0.0 | 21.8 |
| MA8810 | LIGHT ASSAULT BRIDGE | 0.0 | 3.9 | 10.9 |
| ML5315 | ITEMS LESS THAN $2.O (BRIDGING) | 0.7 | 0.8 | 0.6 |
| | **ENGINEER (NON-CONSTRUCTION) EQUIPMENT** | | | |
| G39100 | DISPENSER MINE XM139 | 5.0 | 11.0 | 14.4 |
| G22500 | MIXING & PUMPING UNIT (MPU/TEXS) | 0.0 | 0.0 | 3.0 |
| X00700 | MARKING SYS, CLEAR LANE | 1.8 | 0.0 | 0.0 |
| M17900 | DETECTING SET, MINE, AN/PSS-12 | 3.8 | 0.0 | 0.0 |
| R06100 | MINE PLOW (BLADE) | 8.3 | 0.0 | 0.0 |
| XO0600 | MINE CLEARING ROLLER | 1.4 | 0.0 | 0.0 |
| R21000 | VEHICLE MAGNETIC SIGN DUP | 0.0 | 0.0 | 4.8 |
| M05900 | M-9 ARMORED CMBT EARTHMOVER(ACE)(MYP) | 62.0 | 61.8 | 63.3 |
| ML5320 | ITEMS LESS THAN $2.OM (ENG NON-CONST) | 1.0 | 0.0 | 0.0 |
| MA7800 | MOD IN-SVC EQ (ENGR-NC) | 0.3 | 0.0 | 1.0 |
| | **COMBAT SERVICE SUPPORT EQUIPMENT** | | | |
| MF9300 | AIR COND VARIOUS SIZE/CAPACITIES | 9.8 | 6.9 | 3.0 |
| M86600 | FIELD KITCHEN, MOBILE, TRL MTD | 15.8 | 0.0 | 0.0 |
| M83200 | BAKERY PLANT FIELD | 0.0 | 0.0 | 8.2 |
| R12200 | RIGID WALL SHELTER CMD POST ANNEX | 0.0 | 4.8 | 6.6 |
| MA9500 | DIVING EQUIPMENT | 2.9 | 2.0 | 0.0 |
| MA9600 | FIRETRUCKS | 4.6 | 0.0 | 0.0 |
| M87600 | LAUNDRY UNIT/TRL MTD | 5.9 | 0.0 | 12.0 |
| MB2000 | ARMY PRINTING AND BINDING EQUIPMENT | 2.6 | 0.0 | 0.0 |
| ML5325 | ITEMS LESS THAN $2.OM (CCS-EQ) | 15.1 | 5.3 | 3.4 |
| MA8100 | MOD OF IN SVC EQUIPMENT (CSE) | 0.7 | 0.8 | 0.0 |
| MA8060 | SOF ITEMS LESS THAN 2.0 | 0.0 | 0.7 | 0.7 |
| | **PETROLEUM EQUIPMENT** | | | |
| M19000 | TANK ASSEMBLY FAB COLL POS 50000G | 3.7 | 2.3 | 3.0 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| M64900 | TANK ASSEMBLY FAB COLLAPSIBLE 10K G | 5.6 | 1.1 | 3.1 |
| R21400 | TANK ASSEMBLY FAB COLL, 20K GAL POL | 0.0 | 0.0 | 3.3 |
| M62300 | TANK/PUMP UNIT LIQ DISP F/TRK MNT | 5.1 | 3.0 | 0.0 |
| M73300 | LAB, PETROLEUM, SEMI-TRLR MTO | 1.6 | 1.5 | 3.8 |
| M63900 | PUMP ASBLY LIQ GAS WHL 4 IN OUT 350GP | 0.0 | 0.0 | 7.5 |
| MA5120 | SWA PETROLEUM DISTRIBUTION | 31.0 | 42.1 | 55.6 |
| ML5330 | ITEMS LESS THAN $2.0M (POL) | 3.2 | 1.5 | 2.0 |
| WATER EQUIPMENT | | | | |
| R05100 | WTR PUR LTNIT REV OS 3000 GPH (ROWPU) | 11.7 | 14.3 | 15.9 |
| M15000 | TANK, FAB,COLL,3K GAL WATER (ONION) | 2.4 | 1.1 | 2.5 |
| M11400 | WATER QUALITY ANALYSIS SET PURIF | 0.0 | 0.0 | 1.0 |
| ML5335 | ITEMS LESS THAN $2.0M (WATER EQ) | 3.1 | 3.0 | 5.6 |
| MEDICAL EQUIPMENT | | | | |
| MN1000 | COMBAT SUPPORT MEDICAL | 103.9 | 67.3 | 67.3 |
| MA9900 | MEDICAL SUPPORT EQUIPMENT | 58.3 | 60.6 | 62.4 |
| MAINTENANCE EQUIPMENT | | | | |
| M62700 | WELDING SHOP, TRAILER MTD | 4.4 | 0.6 | 0.0 |
| M61600 | SHOP EQ ELECTRICAL RPR SEMI-TRL MTD | 0.5 | 0.0 | 0.0 |
| ML5345 | ITEMS LESS THAN $2.0M (MAINT EQ) | 1.3 | 11.3 | 9.7 |
| CONSTRUCTION EQUIPMENT | | | | |
| R04800 | SMALL EMPLACEMENT EXCAVATOR (SEE) | 32.6 | 0.0 | 18.3 |
| MA8300 | MODS OF IN SVC EQUIP (CONST EQUIP) | 0.2 | 2.0 | 0.0 |
| ML5350 | ITEMS LESS THAN $2.0M (CONST EQUIP) | 11.3 | 3.1 | 3.4 |
| RAIL FLOAT CONTAINERIZATION EQUIPMENT | | | | |
| M34200 | LANDING, CRAFT, UTILITY | 46.7 | 0.0 | 0.0 |
| M44600 | TUG INLAND & COAST WATERWAYS | 7.5 | 0.0 | 0.0 |
| R97500 | CAUSEWAY SYSTEMS | 3.0 | 0.0 | 3.5 |

FY90 OTHER PROCUREMENT, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| MA8950 | MOD OF IN-SVC EQU (FLOAT/RAIL) | 3.3 | 1.7 | 1.9 |
| ML5355 | ITEMS LESS THAN $2.0M (FLOAT/RAIL) | 3.0 | 0.1 | 2.3 |
| MA9800 | GENERATORS AND ASSOCIATED EQUIP | 29.6 | 41.9 | 52.4 |
| MATERIAL HANDLING EQUIPMENT | | | | |
| M48800 | TRUCK, FORKLIFT, DE, PT, RT | 0.0 | 0.0 | 11.6 |
| M48900 | TRUCK, FORKLIFT, DE, PT, RT, 6000 LB | 21.5 | 21.3 | 20.0 |
| M41300 | TRUCK, FORKLIFT, DE, PT, RT, 4000 LB | 0.0 | 14.1 | 11.8 |
| X00900 | 65 TON CRANE | 6.3 | 0.0 | 0.0 |
| ML5365 | ITEMS LESS THAN $2.0M (MHE) | 1.2 | 1.0 | 4.6 |
| OTHER SUPPORT EQUIPMENT | | | | |
| MB7000 | BASE LEVEL EQUIP | 0.0 | 27.7 | 29.7 |
| MA5550 | PROD ENHAN CAPIT INVET | 0.0 | 4.9 | 4.9 |
| MA5500 | QUICK RET ON INVEST | 0.0 | 2.6 | 2.6 |
| MA0350 | SPARES AND REPAIR PARTS (OTHER) | 48.2 | 30.2 | 38.8 |
| MB2100 | AREA ORIENTED DEPOT UPGRADE | 4.0 | 30.5 | 30.5 |
| MA0450 | PRODUCTION BASE SUPPORT (OTHER) | 9.1 | 15.3 | 13.6 |
| MA5600 | OSD PRODUCTIVITY INVESTMENT FUNDING | 10.0 | 34.1 | 36.4 |
| MA9300 | MFNG METH & TECH | 0.0 | 9.0 | 8.9 |
| MA6700 | SPECIAL EQUIPMENT FOR USER TESTING | 14.8 | 8.1 | 6.7 |
| MA5175 | HOST NATION SUPPORT - EUROPE | 57.4 | 122.3 | 0.0 |
| MA6600 | NATIONAL TRAINING CTR SUP | 25.7 | 20.9 | 23.8 |
| NA0100 | TRAINING DEVICES, NONSYSTEM | 103.8 | 140.3 | 87.0 |
| NA0170 | SIMNET | 15.0 | 13.5 | 23.8 |
| MB7100 | NON-CENTRALLY MANAGED ITEMS | 19.5 | 0.0 | 0.0 |
| | TOTAL OTHER PROCUREMENT, ARMY | 4660.0 | 4233.8 | 4282.4 |

FY90 RESEARCH, DEVELOPMENT, TEST & EVAL, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| | TECHNOLOGY BASE | | | |
| 61101A | IN-HOUSE LAB INDEPENDENT RESEARCH | 0.0 | 9.1 | 9.2 |
| 61102A | DEFENSE RESEARCH SCIENCES | 172.7 | 175.9 | 182.2 |
| 61103A | UNIVERSITY RESEARCH INITIATIVES | 0.0 | 21.9 | 22.2 |
| 62105A | MATERIALS | 11.0 | 13.4 | 13.6 |
| 62120A | ELEC SURVIVABILITY AND FUZING TECH | 37.3 | 28.2 | 28.0 |
| 62122A | SURVIVABILITY ENHANCEMENT | 5.6 | 5.9 | 6.1 |
| 62211A | AVIATION TECHNOLOGY | 45.7 | 41.5 | 42.1 |
| 62303A | MISSILE TECHNOLOGY | 21.8 | 31.0 | 30.5 |
| 62307A | LASER WEAPON TECHNOLOGY | 6.3 | 0.6 | 0.5 |
| 62601A | TANK AND AUTOMOTIVE TECHNOLOGY | 22.2 | 37.2 | 40.3 |
| 62618A | BALLISTICS TECHNOLOGY | 27.2 | 30.3 | 29.0 |
| 62622A | CHEMICAL AND SMOKE MUNITIONS | 41.3 | 54.0 | 54.0 |
| 62623A | JOINT SERVICE SMALL ARMS PROGRAM | 14.1 | 5.1 | 5.2 |
| 62624A | WEAPONS AND MUNITIONS TECHNOLOGY | 31.1 | 39.1 | 40.0 |
| 62705A | ELECTRONICS AND ELECTRONIC DEVICE | 21.7 | 18.2 | 18.4 |
| 62709A | NIGHT VISION INVESTIGATIONS | 25.3 | 19.3 | 19.8 |
| 62716A | HUMAN FACTOR ENGR TECH | 15.0 | 15.0 | 15.3 |
| 62720A | ENVIRONMENTAL QUALITY HEALTH | 9.5 | 12.0 | 12.2 |
| 62727A | NON-SYSTEM TRAINING DEVICES | 3.4 | 4.4 | 4.5 |
| 62782A | C3 TECHNOLOGY | 12.5 | 21.9 | 23.2 |
| 62783A | COMPUTER & SOFTWARE TECHNOLOGY | 6.4 | 5.5 | 5.7 |
| 62784A | MILITARY ENGINEERING TEC | 39.9 | 45.2 | 47.7 |
| 62785A | MANPOWER/PERSONNEL/TRAINING TECHNOLOG | 17.8 | 17.1 | 17.1 |
| 62786A | LOGISTICS TECHNOLOGY | 39.9 | 37.3 | 37.9 |
| 62787A | MEDICAL TECHNOLOGY | 105.7 | 96.4 | 95.5 |
| 62788A | TRACTOR FLOP | 0.0 | 1.8 | 1.8 |
| | ADVANCED TECHNOLOGY DEVELOPMENT | | | |
| 63001A | LOGISTICS ADVANCED TECHNOLOGY | 9.8 | 12.5 | 12.0 |
| 63002A | MEDICAL ADVANCED TECHNOLOGY | 34.3 | 34.7 | 37.2 |
| 63003A | AVIATION ADVANCED TECHNOLOGY | 36.2 | 32.0 | 34.2 |
| 63004A | WEAPONS AND MUNITIONS ADVANCED TECH | 76.5 | 48.8 | 33.2 |
| 63005A | COMBAT VEH & AUTO ADV TECH | 58.7 | 139.5 | 164.4 |
| 63006A | C3 ADV TECH | 7.7 | 11.7 | 11.1 |
| 63007A | HUMAN FACTORS/PSNL/TNG | 29.4 | 18.9 | 19.7 |
| 630012 | TRACTOR HOLE | 0.0 | 9.1 | 4.5 |
| 630013 | TRACTOR DIRT | 0.0 | 1.8 | 1.2 |
| 63102A | MATERIALS AND STRUCTURES | 6.9 | 4.7 | 5.2 |
| 63105A | ACQUIRED IMMUNE DEFICIENCY RESEARCH | 27.0 | 0.0 | 0.0 |
| 63302A | JT TAC MISSILE DEF | 31.3 | 36.1 | 35.0 |
| 63303A | MLRS TERM GUID WARHEAD | 35.9 | 47.1 | 47.2 |
| 63313A | MSL/ROCKET COMPONENTS | 13.5 | 10.7 | 8.8 |
| 63314A | HIGH ENERGY LASER & DIRECTED ENERGY | 7.7 | 26.1 | 56.4 |
| 63324A | ARMY DEVELOPMENT AND EQUIP ACTIVITY | 5.0 | 3.9 | 3.5 |
| 63606A | LANDMINE WARFARE/BARRIER DEV | 9.0 | 11.3 | 14.0 |

FY90 RESEARCH, DEVELOPMENT, TEST EVAL, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| 63607A | JOINT SERVICE SMALL ARMS PROGRAM | 9.6 | 6.8 | 5.9 |
| 63710A | NIGHT VISION ADVANCED DEVEL | 23.6 | 21.8 | 23.3 |
| 63833A | ENVIRONMENTAL QC EQUIP | 7.3 | 0.0 | 0.0 |
| 63734A | ENGINEERING SYSTEMS | 2.3 | 3.6 | 3.7 |
| 63742A | ADV ELECTRONIC DEVICES DEV | 6.4 | 6.8 | 7.1 |
| 63758A | ARMY BATTLEFIELD TECH INTEGRATION | 8.6 | 2.6 | 2.5 |
| 63759A | CB DEF/SMK ADV TECH DEMOS | 3.4 | 4.0 | 4.0 |
| 63772A | ADV TACTICAL COMPUTER SCIENCE & TECHN | 6.5 | 4.5 | 4.7 |
| | TACTICAL PROGRAMS | | | |
| 63612A | ADV ANTI-TANK WEAPON SYS(MEDIUM) | 47.0 | 69.6 | 24.8 |
| 63313A | MSL/ROCKET ADV TECH | 13.5 | 10.7 | 8.8 |
| 63314A | DIRECTED ENERGY | 7.7 | 26.1 | 56.4 |
| 63324A | ADEA | 5.0 | 4.0 | 3.5 |
| 63619A | LANDMINE/BARRIER SYSTEM | 12.4 | 4.2 | 6.0 |
| 63627A | SMOKE MUNITIONS & MATERIEL CONCEPTS | 5.0 | 8.8 | 12.2 |
| 63642A | MSAM | 0.0 | 4.7 | 6.8 |
| 63706A | IDENT FRIEND OR FOE DEVELOPMENT | 14.8 | 0.0 | 0.0 |
| 63713A | ARMY DATA DISTRIBUTION SYSTEM | 19.8 | 19.4 | 13.1 |
| 63747A | SOLDIER SUPPORT/SURVIVABILITY | 3.4 | 6.8 | 8.6 |
| 63757A | FORWARD AREA AIR DEFENSE SYSTEMS | 96.9 | 20.2 | 0.0 |
| 63774A | NIGHT VISION SYS ADVANCED DEVELOPMENT | 4.0 | 5.1 | 5.2 |
| 63776A | AIRBORNE ADVERSE WEATHER WEAPONS SYS | 86.6 | 23.2 | 0.0 |
| 63777A | FOLLOW-ON LANCE - ADV DEV | 7.4 | 0.0 | 0.0 |
| 63801A | AVIATION ADVANCED DEVELOPMENT | 4.3 | 23.0 | 15.1 |
| 63802A | WEAPONS & MUNITIONS ADV DEV | 22.2 | 48.1 | 47.6 |
| 63803A | CHEMICAL SYSTEMS ADV DEV | 0.0 | 7.2 | 27.7 |
| 63804A | LOG & ENGR EQUIPMENT ADV DEV | 12.9 | 17.7 | 15.9 |
| 63805A | CSS COMPUTER SYSTEM EVAL/ANALYSIS | 1.4 | 6.3 | 8.1 |
| 63806A | CHEM/BIO DEFENSE EQUIP ADV DEV | 7.4 | 20.0 | 24.2 |
| 63807A | MEDICAL SYSTEMS ADV DEV | 36.1 | 27.3 | 28.4 |
| 64202A | AIRCRAFT WEAPONS | 4.4 | 9.6 | 7.5 |
| 64216A | AIRCRAFT PROPULSION SYSTEM | 55.5 | 51.7 | 53.0 |
| 64223A | LIGHT ARMED SCOUT HELICOPTER | 124.0 | 240.7 | 446.6 |
| 64310A | HELIBORNE MISSILE - HELLFIRE | 3.0 | 0.0 | 0.0 |
| 64313A | GRASS BLADE | 4.7 | 0.0 | 0.0 |
| 64324A | ARMY TACTICAL MISSLE SYSTEM-ARMY | 76.0 | 46.8 | 0.0 |
| 64604A | MED TAC VEH | 24.8 | 18.4 | 6.9 |
| 64609A | SMOKE MUNITIONS AND MATERIEL | 8.3 | 14.2 | 11.1 |
| 64611A | ADVANCED ANTI-TANK WPN SYS - ED | 110.0 | 158.7 | 45.0 |
| 64622A | FAMILY OF HVY TACTICAL VEHICLES | 28.7 | 5.4 | 0.0 |
| 64630A | M1A1 DEVELOPMENT PROGRAM | 0.0 | 0.0 | 45.8 |
| 64709A | ID FRIEND OR FOE EQUIP DEV | 25.6 | 25.1 | 21.3 |
| 64710A | NIGHT VISION DEVICES | 17.6 | 19.4 | 17.5 |
| 64713A | COMBAT FEEDING, CLOTHING AND EQUIP | 2.4 | 5.9 | 6.3 |
| 64715A | NONSYSTEM TRAINING DEVICES ENGINEERING | 21.8 | 17.1 | 32.4 |
| 64723A | SPECIAL PURPOSE DETECTORS | 0.5 | 0.5 | 0.5 |
| 64726A | METEOROLOGICAL EQUIP & SYSTEMS | 1.6 | 0.0 | 0.0 |
| 64741A | AIR DEFENSE COMMAND, CONTROL & INTEL | 92.4 | 71.7 | 75.7 |
| 64746A | AUTOMATIC TEST EQUIPMENT DEVELOPMENT | 9.3 | 10.3 | 9.4 |
| 64770A | JOINT STARS | 22.8 | 39.6 | 50.9 |

FY90 RESEARCH, DEVELOPMENT, TEST EVAL, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| 64779A | JT INTEROP OF TAC CMD & CONT SYS | 9.5 | 4.6 | 4.9 |
| 64801A | AVIATION ENG DEV | 11.0 | 16.6 | 20.0 |
| 64802A | WEAPONS & MUNITIONS ENGNRNG DEV | 12.0 | 9.4 | 6.4 |
| 64803A | CHEMICAL SYSTEMS ED | 33.8 | 31.4 | 6.4 |
| 64804A | LOG & ENGR EQUIP ED | 13.5 | 32.5 | 26.2 |
| 64805A | C3 ED | 10.3 | 11.9 | 1.4 |
| 64806A | CHEM/BIO DEFENSE EQUIP ED | 13.2 | 41.6 | 36.0 |
| 64807A | MEDICAL MATERIEL/MEDICAL BIO DEF ED | 20.0 | 19.6 | 21.3 |
| 64808A | LANDMINE WARFARE/BARRIER EQUIP ED | 14.8 | 13.7 | 18.3 |
| 64810A | FOG-M ENG DEV | 96.5 | 139.3 | 98.3 |
| 64813A | TRACTOR PULL | 0.0 | 4.9 | 34.7 |
| 64814A | SADARM ENG DEV | 145.6 | 155.0 | 104.6 |
| 64815A | TRACTOR TRAILOR | 0.0 | 4.9 | 5.0 |
| 64816A | AAWS ED | 0.0 | 89.0 | 147.0 |
| 64817A | TRACTOR, BALL | 16.0 | 9.6 | 2.5 |
| 64818A | ARMY TAC C3I | 8.0 | 11.2 | 11.5 |
| 64819A | AAWS-H | 0.0 | 0.0 | 79.0 |
| 64820A | FAAD GND BASED SENSOR | 0.0 | 17.2 | 20.3 |
| 64821A | FOLLOW-ON LANCE | 0.0 | 32.8 | 128.6 |
| 23726A | ADV FIELD ARTILLERY TACT DATA SYS | 15.6 | 37.5 | 39.3 |
| 23735A | COMBAT VEHICLE IMPROVEMENT PGM | 96.5 | 91.7 | 67.7 |
| 23739A | AN/TSQ-73 MODIFICATIONS AD C2I MODS | 8.6 | 0.0 | 0.0 |
| 23740A | MANEUVER CONTROL SYSTEM | 12.0 | 7.4 | 20.2 |
| 23743A | 155MM SELF-PROPELLED HOWITZER IMPROV | 24.4 | 10.7 | 3.7 |
| 23744A | AIRCRAFT MODIFICATIONS/PIP | 90.2 | 110.5 | 72.8 |
| 23745A | EQUIPMENT UPGRADE | 19.8 | 0.0 | 0.0 |
| 23751A | SPECIAL OPERATIONS FORCES EQUIPMENT | 118.4 | 58.5 | 46.2 |
| 23752A | AIRCRAFT ENGINE COMPONENT IMPROVEMENT | 5.7 | 5.8 | 6.9 |
| 23801A | MISSILE/AIR DEFENSE PIP | 39.0 | 50.9 | 53.0 |
| 23802A | OTHER MISSILE PRODUCT IMPROVE PGM | 40.0 | 49.3 | 45.4 |
| 23806A | TRACTOR RIG | 0.0 | 14.0 | 22.7 |
| 23808A | TRACTORCARD | 11.0 | 12.0 | 10.0 |
| 23809A | DRAGON III | 5.5 | 0.0 | 0.0 |
| 27316A | TACIT RAINBOW | 0.0 | 57.7 | 72.7 |
| 28010A | JOINT TACTICAL COMMO PROGRAM (TRITAC) | 13.8 | 0.0 | 0.0 |
| 33145A | EUCOM C3 SYSTEMS | 0.6 | 0.0 | 0.0 |
| | INTELLIGENCE AND COMMUNICATIONS | | | |
| 64716A | TERRAIN INFO | 6.5 | 12.9 | 11.6 |
| 64778A | NAVSTAR GLOBAL POSITIONING SYSTEM | 8.8 | 7.7 | 8.2 |
| 33142A | SATCOM GROUND ENVIRONMENT | 26.5 | 43.1 | 35.1 |
| | DEFENSEWIDE MISSION SUPPORT | | | |
| 65301A | KWAJALEIN MISSLE RANGE | 155.3 | 157.7 | 164.7 |
| 65601A | ARMY TEST RANGES AND FACILITIES | 191.0 | 226.9 | 235.3 |
| 65602A | ARMY TECH TEST INSTRU & TARGETS | 59.8 | 68.9 | 91.6 |
| 65603A | ARMY USER TEST INSTRU AND THREAT SIMU | 43.7 | 67.4 | 60.1 |
| 65702A | MET SUPT TO RDTE ACTIVITIES | 18.8 | 23.5 | 24.0 |

FY90 RESEARCH, DEVELOPMENT, TEST & EVAL, ARMY

| SSN | NOMENCLATURE | FY89 | FY90 | FY91 |
|---|---|---|---|---|
| 65706A | MATERIEL SYSTEMS ANALYSIS | 23.7 | 25.5 | 26.0 |
| 65712A | SUPPORT OF OPERATIONAL TESTING | 51.2 | 70.9 | 75.1 |
| 65801A | PROGRAM WIDE ACTIVITIES | 82.8 | 95.4 | 97.5 |
| 65802A | INTL COOPERATIVE RESEARCH AND DEV | 1.1 | 1.8 | 1.9 |
| 65803A | TECHNICAL INFO ACTIVITIES | 5.7 | 12.6 | 12.7 |
| 65805A | MUN STANDTRD EFFECTIVENESS & SAFETY | 13.0 | 17.7 | 17.7 |
| 65810A | RDTE SUPP FOR NON-DEVELOP ITEMS | 18.2 | 7.5 | 7.6 |
| 65872A | PRODUCTIVITY INVESTMENTS | 49.7 | 19.2 | 19.2 |
| 65894A | REAL PROPERTY MAINTENANCE (RDT&E) | 161.0 | 175.3 | 178.4 |
| 65896A | BASE OPERATIONS (RDT&E) | 183.4 | 198.7 | 203.0 |
| 65898A | MGT HQ (RESEARCH/DEVELOPMENT) | 9.9 | 14.8 | 15.0 |
| 78011A | INDUSTRIAL PREPAREDNESS | 19.7 | 34.5 | 36.1 |
| TOTAL RESEARCH DEVELOPMENT TEST & EVAL, ARMY | | 5117.4 | 5603.0 | 5873.7 |



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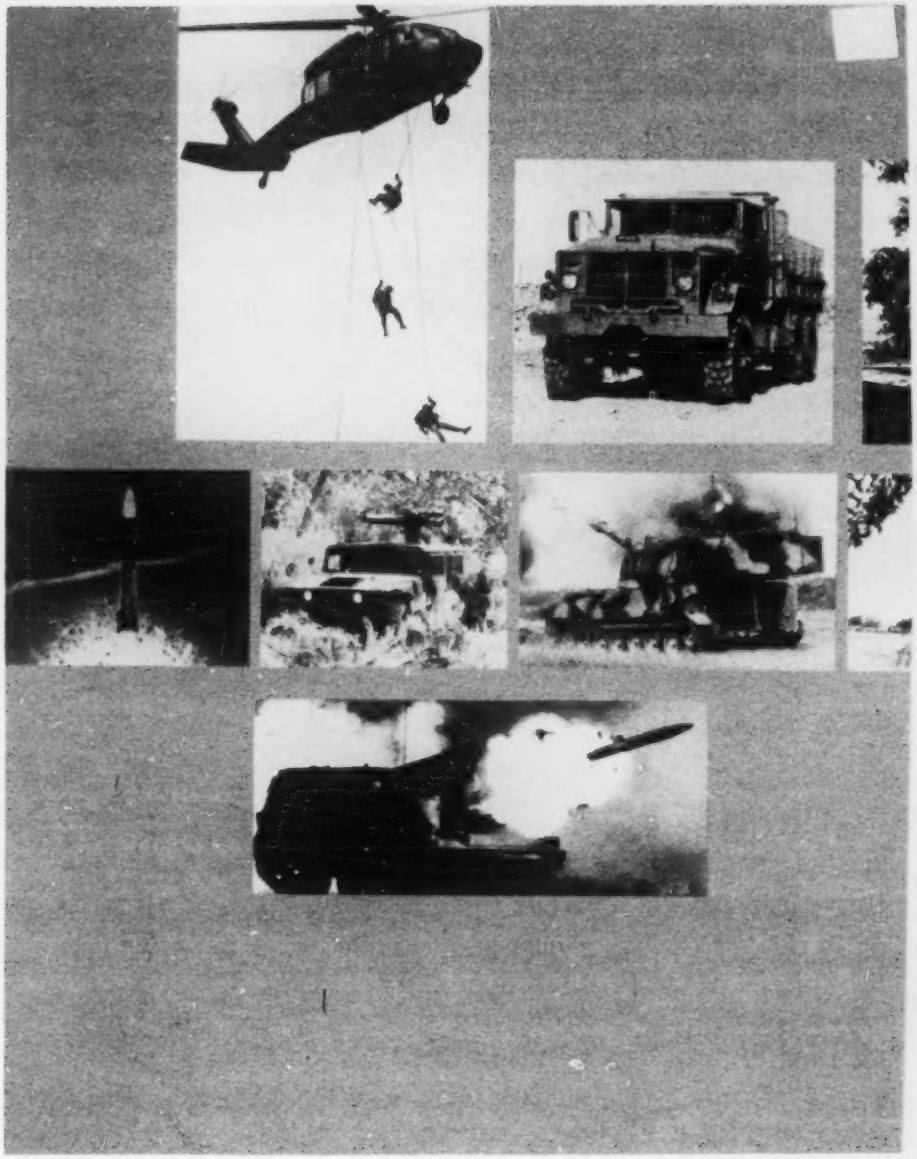

Mr. DELLUMS. We would appreciate your response. If there are differences that exist between the two budgets of such magnitude that it is important for you to come back to discuss these matters with us, we would like to invite you to come back to the committee for such a discussion.

The subcommittee will stand in adjournment until 10 a.m. Tuesday when the subject matter will be the Strategic Defense Initiative. Location to be determined.

[Whereupon, at 12:35 p.m., the subcommittee was adjourned until Tuesday, March 14, 1989 at 10 a.m.]

# STRATEGIC DEFENSE INITIATIVE ORGANIZATION RDT&E BUDGET REQUEST FOR FISCAL YEAR 1990

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Tuesday, March 14, 1989.*

The subcommittee met, pursuant to call, at 10:05 a.m., in room 2337, Rayburn House Office Building, Hon. Ronald V. Dellums, (chairman of the subcommittee) presiding.

## STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The Subcommittee on Research and Development will come to order.

This morning, the Research and Development Subcommittee will take testimony on the Strategic Defense Initiative program. Our witness will be Lt. Gen. George L. Monahan, Jr., Director of the Strategic Defense Initiative Organization.

General Monahan was confirmed to this position last fall and officially became the Director in February, with the retirement of General Abrahamson.

The Reagan budget request for the research and development portion of SDI is about $5.6 billion, representing almost a $2 billion increase over the authorized level of $3.6 billion in fiscal year 1989. Between fiscal year 1985 and fiscal year 1989, the administration has requested about 5.5 billion more than the Congress has appropriated for the Strategic Defense Initiative. Each year, 1985 through 1989, the Congress has reduced the request somewhere between 20- and 30 percent.

General Monahan, I would think that given this past history and the extreme pressures on the budget this year, that chances of achieving this $5.6 billion level for the SDI program are extremely remote. Based on history, a level closer to $3.5 to $4 billion would represent a more realistic estimate of the outcome, although I personally believe that it should go even lower and focus solely on basic research.

It would seem to the Chair that there must be, from even the most ardent supporter of the efficacy of this program, concern with respect to the administration's ability to efficiently run a program that must be adjusted 20–30 percent downward each year over the requested level. I would think that this would be an extremely inefficient operation.

I know of no other defense program where the Congress has consistently reduced a program and the administration has continued to come in with over-optimistic funding requests 6 or 7 years in a row. I would hope that this new administration could define a more clear set of objectives for the SDI program and seek approval of these objectives from Congress and debate on the merits or the lack thereof so that a more stable funding profile can be established in the out-years.

General Monahan, I appreciate the fact that you are just now taking over this job and we do not have a confirmed Secretary of Defense, but I would ask that you articulate as best you can the objectives of the program and provide any insights that you might have on the options that you are looking at as President Bush works through his reduced military budget.

Before you begin, I would like to recognize my distinguished colleague, the gentleman from Alabama, Mr. Dickinson, for such time as he may consume for any comments he deems appropriate at this time.

**STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE**

Mr. DICKINSON. Thank you, Mr. Chairman, and thank you, General Monahan, for your appearance here today. We welcome you to your first congressional appearance in your new role as Director of SDIO.

It is my understanding that you are here today to discuss SDI's current status, as well as President Reagan's $5.6 billion request level, which should make for a lively discussion. We all understand the difficulty inherent in your current position due to the leadership vacuum in the Pentagon and the general lack of policy direction from the executive branch at this point.

I gather that you do not intend to venture into the realm of the SDI policy today. Such a decision is wise and I think such a decision would be wise for all program managers. It is more important that a program manager view his or her role, in my opinion, to answer technical questions such as can we, rather than should we. It would be useful for the subcommittee if you would discuss briefly what you perceive your role to be and providing your views up front will hopefully allow the subcommittee to pursue appropriate issues and to avoid turning this hearing into a protracted and inconclusive policy debate.

To the extent you are able, the subcommittee would also be interested in hearing about any policy guidance that you might have received to date from the new Bush administration. As my chairman alluded to, the Reagan budget, we feel, is not practical.

We have seen the Congress year after year scale it back—even though we are supporters of the program in general—to what we felt was a more practical funding level.

Finally, let me express one broad concern I have on this year's program. Last fall, a lot of political blood was shed in the battle to prevent certain factions in Congress from micromanaging the $4.1 billion that it authorized. One of the primary reasons that I urged

the president to veto the defense budget was due to the fact that after we had dramatically reduced the funding for the SDI program, some in the Congress wanted to go in, and micromanage a big portion of the balance, absolutely denying the flexibility to the Director of going forward with the most promising programs and being able to delete those programs that didn't show as much promise.

There was a lot of debate and a lot of concern over this. As a result of the veto, we were able to do away with most of the fencing. As a matter of fact, as it turned out, I think the president came out looking pretty good in the whole matter.

The centerpiece of the battle was the SBI, space-based interceptor program, a program that certain members wanted to cut by 25 percent and, as I said, micromanage the rest. As part of the post-veto compromise, however, Secretary Carlucci explicitly reassured Congress that no individual SDI program would receive a budget reduction that was disproportionate to the approximately 18 percent funding cut that the overall program took. In our conference with the Senate, Nunn, Warner, Chairman Aspin and myself met with Carlucci, and wrestled with this problem—I think we had two or three meetings on it—this is what we were then told.

Despite the guarantee, though, the 1989 space-based interceptor program was down-scoped dramatically. At some point in the discussion here today, I would appreciate it if you could explain how and why the SBI program was reduced, and if you agree with that reduction or if some effort will be made on your part to remedy what has been done.

We have a lot of ground to cover today, so I will take no more time. I look forward to your testimony, General, and again I would like to wish you well in your new endeavor and welcome you here. I am sure we will be seeing a lot of you in the weeks to come.

Thank you, Mr. Chairman.

Mr. DELLUMS. Thank you. The gentleman yields back his time, and General Monahan, without objection, the full text of your testimony will appear at the appropriate point in the record and you may proceed in any fashion that you choose.

## STATEMENT OF LT. GEN. GEORGE L. MONAHAN, DIRECTOR, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

General MONAHAN. Thank you very much, Mr. Chairman. As you just mentioned, I do have a statement for the record that I propose to submit. But, first of all, in doing a presentation, I am going to bring up the questions you just raised, so that we will get to those, and I will make sure that we save time because those are very important questions that both of you just added on.

As you know, we have a strategic review under way in the executive branch at the present time. That executive review is looking at all of our strategic programs, including the Strategic Defense Initiative, and because of that, the program that is in the president's budget at the present time is probably going to be changed, and it may be changed substantially. I don't really know how much and I don't know if our objectives will be changed a lot. I expect that when the strategic review is completed and when a revised presi-

dent's budget is submitted, should one be coming, that the Strategic Defense Initiative will be impacted, just as will many, many other programs.

I think it is very useful that we understand that the program does, indeed, have a baseline that was approved by the Defense Acquisition Board last fall. That is the program that is in the current president's budget. I propose that I take you through some of that so that you can understand that program, because various options for proceeding in the future will logically be derived from there.

That is why I have a handout that I believe all of you should have. I would like to proceed and go through that particular handout with you and just bring out some of the high points that are involved.

On the second page, there is a listing of the SDIO objectives. They have not changed, in the broad sense, over a period of a few years. You should note that it says to conduct a vigorous research program, to develop the key technologies against the ballistic missiles, and look at options for deployment and to carry out a program in consultation with our allies. I think working the program with our allies is a major aspect of it that is very important.

On the third page, the current program structure is based on the original SDI charter and it is worked against a requirement from the Joint Chiefs of Staff. So, the program that is in the president's budget at the present time is backed up by a JCS requirement. The Defense Acquisition Board met in October, 1988 and approved the program proceeding into a demonstration/validation phase for most of the elements that are in the first phase.

We go to the next page, number 4. This describes the program that is in the president's budget and was approved by the DAB. You will note that on the right-hand side that it is divided into two phases, a phase 1 and a phase 2. I am going to concentrate mostly on phase 1 today.

Phase 1 is further divided into three major elements: the sensors, the command and control and the initial interceptors. Those will be kinetic kill-type interceptors.

Note that the sensors would come first in the development and, indeed, we are in the demonstration/validation phase of the sensors at this time and one of the sensors, the boost surveillance and tracking system, could enter full-scale development as early as next year.

The command and control system comes a little bit after that and finally the interceptors. Advanced weapons, then, come in phase 2.

If we go to page 5, this just kind of encapsulates what I said. Note that in the first phase of the program, it is kind of a large green area there and that depicts a couple of things. Number one, and in the first phase of the program we will be building the basic infrastructure upon which the subsequent phases would be built.

Second, the first phase of the program, you will note, says kinetic energy interceptors. So the first phase would concentrate on those. Those are interceptors that destroy ballistic missiles or reentry vehicles simply by collision. No explosive charge or munition of any sort.

We get into subsequent phases, phase 2 and phase 3, then we get into the directed-energy weapons, such as lasers, either ground-based or space-based or neutral particle beam weapons.

On page 6 is, as the chairman pointed out, a history of the funding versus the president's budget request in the past. I just want to make one point here. If I take the 3.7 billion that was appropriated for fiscal year 1989, then in order to pursue the program that I am going to describe to you, which, as I said, will probably be altered in the strategic review, then the funding there, 5.6 in 1990 and 6.7 in 1991 would be required to pursue this particular program.

Go to page 7. I would begin to describe the phase 1 system and the job that it is to do. First of all, go from right to left on the chart. It is useful to describe the path that a ballistic missile takes in the various phases of its flight. First is the boost phase. I think that is self-explanatory.

Then in the post-boost phase, the boosters have dropped away from the missile and the reentry vehicles that are on what we call the bus, on the top of the missile, then start to deploy. When you get to the mid-course phase, then all the reentry vehicles and any decoys are flying on their own. They are now deployed from the bus and finally, when you get into the terminal phase, they are reentering the atmosphere.

As I describe the program, I am going to first of all describe sensor elements we will again start from right to left on the chart—describe the sensors that look for the initial boost phase that finally look to the terminal phase. Then I will talk about interceptors, space-based interceptors, which would have the objective of intercepting boosters in the booster/post-boost phase and finally reentry vehicles by ground-based interceptors in the mid-course phase or terminal.

The next page—and I have just made a separate sheet to hand out because we can get wrapped in alphabet soup in this program very quickly. This is just—and you might just want to keep that handy, because it describes what these abbreviations are for that I will be—what the abbreviations mean, the abbreviations I will be using throughout the presentation.

The first sensor, if I go to page 9, is what we call the BSTS, the Boost Surveillance and Tracking System. Its job is to look at the entire globe from a very, very high orbit, geosynchronous orbit, and it does, in that sense, the same thing that current satellites do today, and it can detect, among other things, ballistic missile launches. It could detect ICBMs, IRBMs, SLBMs. It will acquire missiles that have been launched, start to track them, determine what type they are and try to give us an assessment of whether or not we are able to destroy them, and then it plays a big role in communications and battle management.

On the next page, 10, you will see an artist's conception of two of the concepts that are possible for BSTS. We have two contractors at the present time and they are in a demonstration/validation phase with these two types of satellites, but it is also possible for other contractors, when we go into full-scale development, to enter the competition, should they have other satellites that would meet our requirements.

The 11th page, then, is a depiction of the coverage that a BSTS has, and I tried to draw this particular chart to scale as far as the earth and where the orbit is with the geosynchronous orbit 22,000 miles above the earth, and note that we would envision a system of probably six satellites. That gives us good overlapping coverage of all areas of the earth at all times.

So that is the first sensor and that is the sensor that would detect the initial launch of a ballistic missile, from wherever it occurred on the earth.

The next sensor is the Space Surveillance and Tracking System. Besides being able to track ballistic missile boosters, it also has the capability to track reentry vehicles or at least clusters of reentry vehicles and the post-boost vehicle. The post-boost vehicle is the vehicle on which the reentry vehicles are mounted and it is from the post-boost vehicle that they are deployed.

It would act as a fire-control sensor for Space-Based Interceptors. It would be able to at least see clusters of reentry vehicles and decoys and could hand those off to the ground surveillance systems and the Ground-Based Radar.

On page 13 is an artist's conception of what a Space Surveillance and Tracking System (SSTS) satellite would look like.

Page 14 is, I think, a little bit more interesting because it shows the the coverage of these SSTS. Note, they have kind of a donut shape coverage and because they don't have to look at the earth—and we very purposely do not have them staring at the earth, but rather out into space, that way they don't have to worry about the clutter that comes from the earth background and are able to see much, much smaller objects than that Boost Surveillance and Tracking System was able to.

Then the third sensor in the system, as we now get down to finer and finer grain of tracking, is the Ground-Based Surveillance and Tracking System (GSTS) which is there to discriminate reentry vehicles from decoys or other penetration aids. It also is a backup to the SSTS should the SSTS be attrited or somehow or another compromised and also the capability to track objects at lower altitudes.

An artist's depiction on page number 16, and the one thing that may or not be evident from this, but this is a suborbital device; i.e., it does not go into orbit. It is launched from the ground as we get a warning from the BSTS or the SSTS that there is a raid incoming and it is launched.

Now, on the next page, number 17, you will see the potential coverage where those may be launched from, but it has a lifetime of maybe 15 or 17 minutes, something of that sort, but in that period of time, is able to discriminate between reentry vehicles and possible decoys and pass that information down through the command and control system.

Finally, the most fine-grained element of the system, on page number 18 is a Ground-Based Radar. This is the first time that radar comes into play among these sensors. The previous sensors I described all were infrared type sensors. Now we are using a radar so that the characteristic radar of being able to do some very fine-grained observation for us can now come into play.

Here is an artist's conception on page 19 of either perhaps a mobile version of a Ground-Based Radar or one that is stationary.

There are various concepts we have under consideration at the time. This is one of the sensor elements that has not yet entered into the demonstration/validation phase, but it will very, very shortly. The other elements I just described were all in the demonstration/validation phase.

Finally, those are the sensors now that I have described. I described them from those that take the look, able to just detect boosters, to those that can detect and discriminate reentry vehicles. To tie it all together, we need a command and control system. On page number 20, I begin to talk about that.

Note the first bullet on there. Through any scheme that I have ever heard of for the Strategic Defense Initiative, man is in control. Man is in the loop in controlling these various elements of the system, so the decision authority rests there. There is no such thing as an automatic initiate or anything of that sort.

We would plan—and our thinking is not all that well defined at the present time—but we would plan on fixed command centers within. For reasons of survivability, I think we clearly have to have mobile command centers also. The command and control system for SDI promises to be very complex. I don't see anything that is really undoable about it. It will be a complex system to engineer.

On the next page, 21, is a picture of what we call EV-88, an early version. That is a picture from down at Huntsville, AL, where the Army's Advanced Research Center has been doing some advanced simulation work for us and are fairly well along on coming up with concepts that will work well in the command and control.

So, now, getting to page 22, I have described the sensors; I have described the command and control system; now let's look at the interceptors themselves, the kill vehicles themselves.

By the way, what I just showed you in the way of the sensors—those may or may not be treaty-compliant. In other words, what I have just described, in a command and control system, there is still—some of those have the possibility of not being treaty compliant. For example, the GSTS has a role that is not only SDI, but also has the role of replacing the DSP satellites we have today, and a Space Surveillance and Tracking System also has the role of looking for ASATs and tracking lots of objects in space, which is becoming more and more important to us.

So deployment of those sensors may be treaty-compliant. We don't know yet and our treaty-compliance people are looking at them.

Now what I am about to describe to you in the interceptors—these clearly are not treaty-compliant when you get to the deployment phase. You can make some arguments perhaps about testing of them, but when you get to deployment, then the interceptors I am going to talk about now would not be treaty-compliant, which says we really need to start to work on just what we are going to do about the ABM Treaty.

Let me, though, describe the Ground-Based Interceptor and then, second, the Space-Based Interceptor. The Ground-Based interceptor will be fairly light weight, hopefully very, very low cost. They would be deployed in some fashion not all that different from anti-aircraft, surface-to-air missiles, and using the sensors I have just

described, would be launched to make a kinetic kill. Again, kinetic is important. In other words, there is no explosive charge of any sort. They simply collide with the reentry vehicles, either in the terminal phase or in the mid-course phase.

Here is the experiment version—one we call the ERIS, on page number 23, and it utilizes in the experimental version, the second and third stage of Minuteman missiles—we make some economies there and then you see blown up what the guidance and the kinetic kill section of the vehicle looks like.

The next is the Space-Based Interceptor (SBI) and I think that is just very descriptive, the words themselves. It is based in space. These are indeed satellites and, again, use the kinetic kill type mechanism. There is no explosion of any sort involved with them.

On page number 25, you will see the depiction of what the coverage of these would be as they are in orbit. You see the many, many dots on here. Each one of those dots is meant to represent a carrier vehicle. At the time of the DAB, back in October, the carrier vehicle was envisioned to include 10 Space-Based Interceptors. We are looking at different concepts today, but nevertheless, the principle is still the same. Those Space-Based Interceptors would be in these various orbits around the earth, constantly moving, and obviously, there is the capability there to defend not only the United States, but to shoot down ballistic missiles in their boost phase or post-boost phase no matter where they are launched from and no matter where they are going.

So, the Space-Based Interceptor carries that kind of advantage. It also has the big advantage of being able to hit a missile in its boost phase when it still has all the reentry vehicles on it. The Soviet SS–18 carries—I don't know if this number is classified, so I won't say it, but the SS–18 carries quite a few reentry vehicles. So, if you can get one missile with the Space-Based Interceptor you can kill quite a few reentry vehicles right there.

When you get to the ground-based system, the ground-based system, then, has to take on each reentry vehicle as it enters the atmosphere.

Mr. DICKINSON. General, I have a question concerning the SS–18. If the number of reentry vehicles is classified, who are we keeping it secret from?

General MONAHAN. That is a good question, Mr. Dickinson. I can talk to you later about why I said that, but——

Mr. DICKINSON. Go ahead.

General MONAHAN. Does anybody know the answer? It is not 10. It is not classified, it is 10.

Mr. DICKINSON. Hell, I knew it was 10. Everybody knows it is 10.

General MONAHAN. I know.

If I may, then, review the program here on page number 26. You will note that we tried to lay out when the DEMVAL, the full-scale development and production phases of the program, would occur. Note that the BSTS program, Boost Surveillance and Tracking System, would begin full-scale development earlier than the others and could begin as early as fiscal year 1990.

For the remainder of the systems, we are talking about getting into about fiscal year 1992 or 1993 before that occurs.

Page number 27 is the depiction of the costs as they were presented at the Defense Acquisition Board last fall. You will notice that they went up, and then they came back down, as some major changes were made in the program and the current estimate to proceed with the program, as I just described it, is $69.1 billion, and hopefully, being able to reduce that.

If I may, then, go to the next chart, number 28, and this is perhaps one of the major potential areas for cost reduction, and that is with the Brilliant Pebbles concept. When I described the Space-Based Interceptor a minute ago, I said that they were housed in vehicles that carried 10 apiece. That number is not classified. In the Brilliant Pebbles concept, we would deploy them in singlets. In other words, each missile all by itself. The missile would be—the interceptor would be relatively small, only about a foot long—excuse me, about a yard long, about a meter long, probably weigh about 100 pounds or less, would have some highly dense packaging of the sensors and propulsion system and all that is necessary for it to do its job.

It also differs from our current Space-Based Interceptor concept in that in at least one mode of operation, the Brilliant Pebbles is envisioned to be able to operate autonomously. In other words, it doesn't have to get hand-offs or information from other sensors.

The sensors on the Brilliant Pebbles would have the capability of detecting launches of boosters and then have additional sensors that could guide it to the target should it be enabled by a decision made by man on the ground to let it fly free, to go destroy a target.

So it has an awful lot of operational potential and a lot of potential to reduce costs.

At the same time, there is an awful lot that is still unknown about Brilliant Pebbles, and there is a lot of technical work, a lot of research work left to be done. For example, could the several small sensors onboard the singlet—onboard the Brilliant Pebbles indeed be able to detect what we think it has to detect? Could we, indeed, package the electronics into the small space required? We have never mass-produced anything like this before; there has never been mass production of satellites and these Brilliant Pebbles would be both satellites and they are also something like air-to-air missiles. They are kind of a cross between the two. So that makes it difficult to get a handle, without ever having to try to mass-produce them before, it makes it difficult to try to get a good hand on costing them just at this time.

Yes, and then there is the communication system that would be required. We would envision deploying these in the thousands, many thousands, and they would have to be hooked together by a very robust communication system.

All that I have just described is, I think, doable. I think there is a lot of potential there, but the degree to which you could be successful in a timeframe in which you could be successful and how much it would ultimately cost, I think are all unknowns at this time.

So we are, in our options, looking at—as part of the president's strategic review, we are looking at options that do include robust work as far as Brilliant Pebbles is concerned.

As I said, to wrap it all up, I think there is a lot of potential here with the Brilliant Pebbles program.

Page 29 is just a look, an artist's—no, this is an actual picture of a test vehicle we have there.

Now, from the test of this, I have just described the phase 1 system and described the Brilliant Pebbles. For now, let's start talking about things that would come later, things that will come in phase 2 and beyond.

Again, here is a list of the abbreviations. The HEDI, the Space-Based Laser, Neutral Particle Beam, Ground-Based Laser, et cetera. The first of those is the HEDI, or the High Endoatmospheric Defense Interceptor. Here, we would have a vehicle that is able to intercept the reentry vehicles while they are in the terminal phase.

On page number 32, there is a picture of a test vehicle that we are going to launch this summer.

Space-Based Laser. I think the words speak for themselves. Obviously, you hit something with the speed of light. Note, however, it is a very, very, very large satellite. We think about 220,000 pounds. There is an artist's depiction of such a satellite on the next page.

The next is the Neutral Particle Beam device which could be deployed in space. I am on page 35 now.

Mr. DICKINSON. General, what is capable of putting 220,000 pounds in orbit? Is the shuttle capable? Do we have anything——

General MONAHAN. I don't know. I get worried again about classification. I don't know at the present time, Mr. Dickinson, of a vehicle that we have than can do that.

Mr. DICKINSON. I didn't think so. Is that what we call pie in the sky?

General MONAHAN. No, sir. You have perhaps heard of the Advanced Launch System Program, and when you get to Space-Based Lasers or space-based Neutral Particle Beam weapons, then you do need something that an Advanced Launch System could offer. Up until that time, you probably don't need an Advanced Launch System.

The Neutral Particle Beam weapon, which destroys simply by shooting hydrogen atoms, is another concept and you can see it would be a satellite of substantial size, about 116,000 pounds. That, again, is something for the Phase 2 or Phase 3 program and it is quite a ways out in the future, although some very, very good progress has been made technically in pursuit of this.

Page number 37, I talk about a Ground-Based Laser. Obviously, it can do the same thing as a Space-Based Laser, but on page 38, you note that we have to use relay mirrors in order for it to do its job. So whereas you could keep the laser on the ground, such that it would have access to a very, very large power supply—that is the big advantage of keeping it on the ground—you still have to put satellites in orbit that would have the mirrors on them.

In reviewing the next couple charts, beginning with number 39, I would like to talk just a little bit about what technology has done in the program. You note there has been about $15 billion invested in the program to date, a lot of technical work under way, and these are just a few examples of some things that have come out.

On page 39, you will note an Inertial Measurement Unit—or inertial navigation sat. From the 1970s, it cost about $70,000 and weighs 41 pounds, and you note that under SDI, they have developed that now down to the point where it just weighs about eight ounces. It is about this big and costs only about $8000 and has no moving parts. That is just one example.

Another example on page number 40 of what has been done in the way of divert motors. You note the one over there on the left which is of the vintage of the 1960s and coming all the way over to the right, which has been developed now by—through the SDI program. A great reduction in weight, a great increase in thruster weight and a great reduction in cost per unit.

On page number 41, it shows the same sort of things in computers, and indeed, the generic computer that we would use on various sensor platforms that I mentioned is depicted over on the right and you can see the tremendous decrease in size, but the great increase in through-put capacity. Fifteen million instructions per second versus just 3 million instructions per second from older hardware that is much bigger. So that has been developed.

On page number 42, those of you that are familiar with the Maverick missile—here is the device that I don't try to claim can do the same thing that a Maverick can, but the electronics unit inside of the Maverick weighs about 100 pounds and the electronics unit developed here for the LEAP projectile just weighs half a pound and occupies much less volume.

Those are just a few of the examples of the technology that benefits—not only direct benefit to the SDI program, but is going to benefit many other areas as well.

Just a quick look, beginning on page 43, as to how the budget is broken up by who manages it—obviously SDIO manages all of it. We use the Air Force and the Army, DARPA, the Department of Energy, DNA, the Navy, also as agents. That first chart just shows how that is broken up.

I then get into the program elements, however, on page number 44. That gives all the information as to how it is divided before the major elements of Directed Energy Weapons, Kinetic Energy Weapons, SATKA, et cetera.

One that is perhaps more important, though, is on page number 45. On page number 45, for 1990 and 1991, it shows how much of the budgets are planned to go toward the phase 1 system, the follow-on systems and the technology. Note about 45 percent or 46 percent is technology and about another 40 percent is in the systems area of phase 1 and phase 2 systems.

With that, just a couple of words of summary, Mr. Chairman. There has been substantial investment in the program, a lot of technology advancements have been made and the current budget, as it was put in, maintains a balanced program and then pursues the phase 1 effort that I talked about throughout this presentation.

With that, Mr. Chairman, I would like to make some comments about some of the questions that were asked here just a little bit earlier by yourself and by Mr. Dickinson.

First of all, Mr. Dickinson asked about what is my view of the role of the program manager and I agree with him, the program manager, the role that I have, should be that of the person that

asks what can we do, rather than what should we do? In other words, I think that I should be required to give you as objective an assessment as I can of things such as technical risk, technical difficulty, cost assessment, schedule assessment. I should be able to tell you what we can do and the should do, I think, requires a much, much bigger forum and a much broader forum.

That is what is encouraging about the strategic review that is under way at the present time, because we now have the defense and the offense being considered together in that strategic review. I think that is providing that kind of forum.

For that part, our Organization is making a lot of input on various options as far as the strategic review is concerned. We are telling people, just as I said, how tough is it to do technically? Is it possible to do it technically? How much does it cost? How long does it take, and answering those kinds of questions.

I think Mr. Dickinson also asked about my view on fencing. No program manager that I have ever known ever likes to see his funds fenced. Why? It is very simple. It just takes away flexibility that he has in pursuit of the program. Now, the flexibility he has to have when a program is way downstream in production is nowhere near the kind of flexibility he has to have when a program is way up front in research, in the research and development phase. That is exactly where we are at the present time.

We have not entered full-scale development of any element of SDI. Rather, we are still in the demonstration/validation phase and in that phase, you have to make lots of tradeoffs, first of all, between—should I have the SSTS do this or the BSTS do this or is it better to have that done on the ground or in space? You have to make those kinds of tradeoffs as specifications start to get tightened up.

So it is very important at this stage of the game, it seems to me, if we put together a balanced program that we avoid fencing, if at all possible.

You asked, Mr. Dickinson, also, about the SBI. It was downscoped, and that happened because when the fencing initially occurred and was in the proposed legislation, the SDI Organization took it on itself to reduce that because it looked like they wouldn't be able to spend it anyhow. As a result, I guess some people got laid off and some bad things happened there. It never get restored as back as far as we want it.

Mr. Chairman, according to my notes, I think I've addressed the questions that you asked about specifically and I will be happy to take any other questions you may have.

PREPARED STATEMENT OF LT. GEN. GEORGE L. MONAHAN

Thank you for the opportunity to appear before this Subcommittee today to testify in support of the SDI budget request.

As you are aware, the top-level strategic review and revisions to the President's budget may result in an adjustment to the budget request for SDI and other programs. At present, however, the objectives of the research remain constant and are shown below:

Figure 1. SDI Objectives

## SDIO OBJECTIVES

- Conduct Vigorous Research Program To Develop Key Technologies For Defense Against Ballistic Missiles
- Consider Options To Increase The Contribution Of Defenses To US And Allied Security
- Protect Options For Near-Term Deployment Of Limited Ballistic Missile Defense
- Carry Out Program In Full Consultation And, Where Appropriate, With Participation Of Our Allies

The SDI budget request is $5.6 billion and $6.7 billion for fiscal years 1990 and 1991, respectively. The following charts provide details.

Figure 2. FY 1990-91 Budget Compared To Past Appropriations

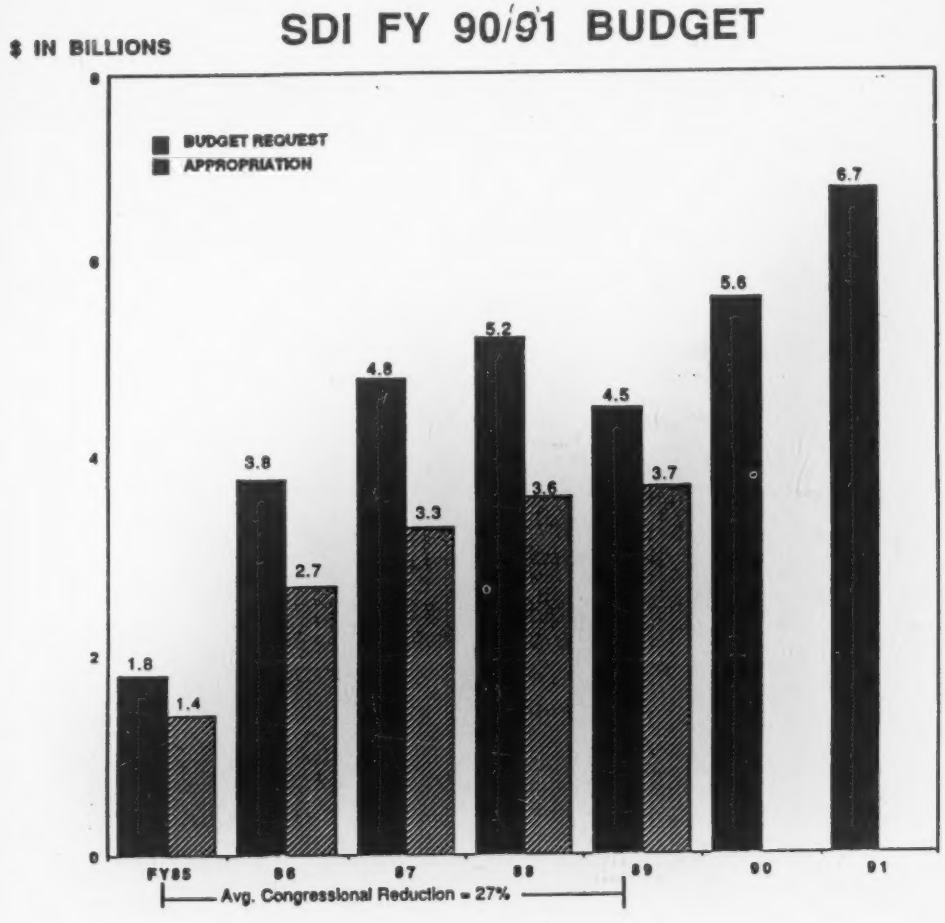
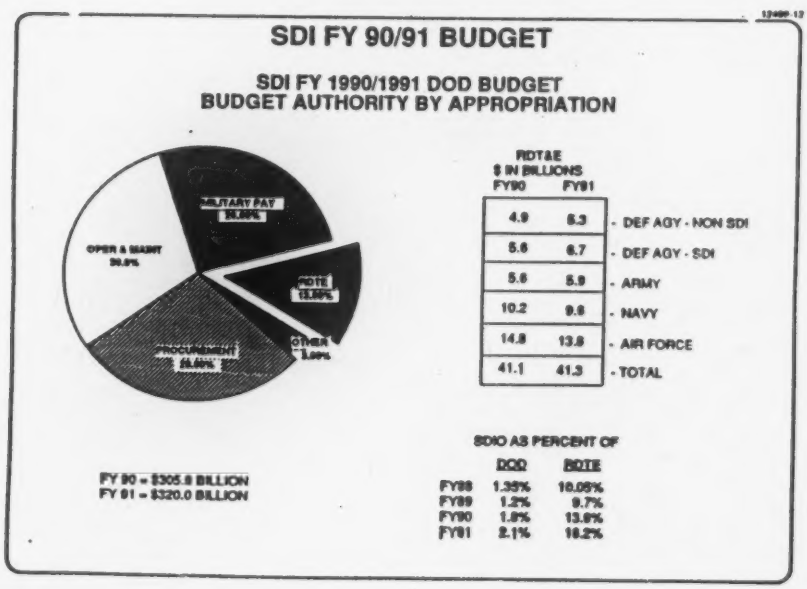


Figure 3. SDIO RDTE Funds by Program ($ million)

| | FY86 | FY87 | FY88 | FY89 | FY90 | FY91 |
|---|---|---|---|---|---|---|
| Sensors | 844 | 923 | 935 | 1101 | 1281 | 1436 |
| Directed Energy | 796 | 853 | 934 | 820 | 1117 | 1323 |
| Kinetic Energy | 596 | 723 | 773 | 773 | 1346 | 1534 |
| Systems Analysis/ Battle Mgmt | 212 | 386 | 461 | 506 | 781 | 976 |
| Survivability, lethality, and Key Technology | 214 | 375 | 430 | 406 | 777 | 948 |
| Boost Surveillance and Tracking System - Full Scale Development | | | | | 262 | 427 |
| HQ MGT | 13 | 20 | 20 | 21 | 26 | 27 |
| Total | 2675 | 3280 | 3553 | 3627 | 5590 | 6671 |

Figure 4. SDIO Budget Request Compared To Other Accounts


SDI FY 90/91 BUDGET
SDI FY 1990/1991 DOD BUDGET
BUDGET AUTHORITY BY APPROPRIATION
RDT&E
$ IN BILLIONS
FY90 FY91
4.9 5.3 - DEF AGY - NON SDI
5.6 6.7 - DEF AGY - SDI
5.6 5.9 - ARMY
10.2 9.6 - NAVY
14.8 13.8 - AIR FORCE
41.1 41.3 - TOTAL
SDIO AS PERCENT OF
DOD RDTE
FY88 1.35% 10.08%
FY89 1.2% 9.7%
FY90 1.8% 13.6%
FY91 2.1% 16.2%
FY 90 = $305.8 BILLION
FY 91 = $320.0 BILLION

## Figure 5. Distribution of SDIO Funds by Project

| PE # | PROJECT # | TITLE | FY90 $ Actual | FY90 $ APPN | FY91 $ Request | FY91 $ Request |
|---|---|---|---|---|---|---|
| 0603220C | | Surveillance, Acquisition, Tracking, and Kill Assessment Projects | | | | |
| | 01 | Radar Discrimination and Data Coll | 16.257 | 21.175 | 28.995 | 28.952 |
| | 02 | Optical Discrimination and Data | 99.678 | 110.984 | 123.622 | 163.747 |
| | 03 | Microwave Radar Tech | 17.298 | 14.323 | 28.996 | 28.963 |
| | 04 | Laser Radar Tech | 79.980 | 80.771 | 96.952 | 101.299 |
| | 05 | Passive Sensor Tech | 95.841 | 71.289 | 96.954 | 105.842 |
| | 06 | Signal Processing Tech | 66.122 | 81.943 | 100.848 | 106.827 |
| | 07 | Innovative Disc Tech | 23.141 | 13.980 | 37.941 | 41.932 |
| | 08 | Boost Dem/Val | 173.998 | 236.000 | 67.511 | 0.000 |
| | 09 | Midcourse Dem/Val | 37.746 | 107.998 | 163.754 | 314.816 |
| | 10 | Midcourse Experiment | 99.701 | 99.991 | 42.930 | 28.963 |
| | 11 | Terminal Dem/Val | 38.992 | 72.383 | 144.475 | 180.343 |
| | 12 | BATKA Support | 117.215 | 122.880 | 217.548 | 214.114 |
| | 81 | IS&T | 99.374 | 43.289 | 96.906 | 114.996 |
| | 82 | Delta Star | 7.900 | 0.000 | 0.000 | 0.000 |
| | 83 | Support Programs | 49.510 | 31.981 | 32.962 | 36.016 |
| | | TOTAL BATKA | 994.909 | 1190.736 | 1291.023 | 1438.000 |
| 0603221C | | Directed Energy Projects | | | | |
| | 20 | FEL | 172.098 | 202.322 | 275.092 | 302.010 |
| | 21 | ATP | 252.348 | 193.691 | 254.817 | 244.810 |
| | 22 | CL | 103.060 | 100.139 | 346.486 | 311.190 |
| | 23 | NPB | 109.018 | 99.298 | 114.829 | 114.796 |
| | 24 | MIRACL/T | 27.900 | 4.000 | 0.000 | 0.000 |
| | 25 | CDTV/Emerging Tech | 167.142 | 96.153 | 64.729 | 62.462 |
| | 81 | IS&T | 19.315 | 15.000 | 34.130 | 40.865 |
| | 82 | Delta Star | 66.218 | 72.962 | 0.000 | 0.000 |
| | 83 | Support Programs | 21.810 | 46.894 | 27.099 | 17.274 |
| | | TOTAL DEW | 934.295 | 819.759 | 1116.902 | 1322.877 |
| 0603222C | | Kinetic Energy Projects | | | | |
| | 30 | Space Systems | 165.000 | 132.000 | 346.296 | 360.412 |
| | 31 | Exo KKV Systems | 116.000 | 202.255 | 244.225 | 293.819 |
| | 32 | Endo KKV Systems | 106.230 | 146.875 | 216.844 | 191.488 |
| | 33 | Advanced Tech Weapons | 117.862 | 99.105 | 217.673 | 311.507 |
| | 34 | Test and Evaluation | 133.105 | 99.015 | 107.137 | 148.983 |
| | 35 | Technology Support | 5.638 | 9.405 | 9.896 | 9.545 |
| | 42 | Theater Defense | 67.998 | 75.787 | 139.280 | 149.957 |
| | 81 | IS&T | 23.365 | 21.702 | 41.277 | 49.190 |
| | 82 | Delta Star | 6.147 | 0.000 | 0.000 | 0.000 |
| | 83 | Support Programs | 32.102 | 39.967 | 22.467 | 22.974 |
| | | TOTAL KEW | 773.167 | 773.111 | 1346.514 | 1634.387 |
| 0603223C | | Systems Analysis and Battle Management Projects | | | | |
| | 40 | SDS Engineering and Support | 72.590 | 82.098 | 131.407 | 201.071 |
| | 42 | Theater Defense | 50.500 | 30.605 | 49.922 | 46.720 |
| | 43 | CC/SCIF Technology | 64.306 | 99.572 | 86.398 | 107.817 |
| | 44 | CC/SCIF Experimental Systems | 91.073 | 74.179 | 143.778 | 203.071 |
| | 45 | National Test Bed | 77.713 | 100.179 | 115.827 | 121.802 |
| | 46 | SDS Phase I Engineering | 46.201 | 63.470 | 125.210 | 155.531 |
| | 47 | Test & Evaluation | 5.861 | 9.477 | 9.986 | 14.977 |
| | 81 | IS&T | 12.995 | 19.350 | 25.932 | 30.902 |
| | 83 | Support Programs | 22.942 | 53.289 | 70.588 | 70.871 |
| | 85 | Technology Applications | 16.468 | 30.277 | 22.967 | 22.965 |
| | | TOTAL SA/BM | 461.459 | 906.476 | 780.964 | 973.827 |
| 0603224C | | Survivability, Lethality, and Key Technology Projects | | | | |
| | 50 | Systems Survivability | 91.305 | 102.991 | 169.430 | 218.114 |
| | 51 | Lethality and Target Hardening | 69.641 | 62.218 | 124.434 | 152.129 |
| | 52 | Power and Power Conditioning | 97.204 | 99.509 | 226.295 | 236.979 |
| | 53 | Space Transportation and Support | 79.536 | 85.000 | 124.809 | 184.750 |
| | 54 | Materials and Structures | 34.890 | 30.731 | 69.429 | 86.061 |
| | 55 | Countermeasures | 21.245 | 22.270 | 34.984 | 42.356 |
| | 81 | IS&T | 23.600 | 19.376 | 40.905 | 49.610 |
| | 83 | Support Programs | 23.131 | 15.249 | 8.472 | 8.578 |
| | | TOTAL SLKT | 429.574 | 406.343 | 776.787 | 947.576 |
| 0604220C | 60 | BSTS PSD | 0.000 | 0.000 | 262.000 | 427.000 |
| 0605699C | 80 | Management Headquarters | 20.026 | 21.000 | 25.394 | 27.456 |

The classified FY 1990 Report to Congress on the SDI Program was submitted to the Congress on January 19, 1989. The unclassified version of that report should be available soon. This report describes in detail the content of the total SDI research program. With your indulgence, I would like to take a few minutes to highlight some very important points from the report. First, the SDI research program seeks both mature and emerging defense options. For example, kinetic energy systems (e.g., rocket-propelled interceptors) -- which will be deployed in the initial phase of a defensive system -- and directed energy weapons (lasers, particle beams) are being researched with equal dedication. Second, the emerging defense options are integral to the program's success in countering potential Soviet responses to a deployed Strategic Defense System (SDS).

In October, 1988, the Defense Acquisition Board (DAB) completed an annual progress review of the technologies previously selected for the demonstration and validation phase of the Defense Acquisition Process. These technologies, constituting Phase I of the Strategic Defense System (SDS), are ground- and space-based sensor systems, ground- and space-based ballistic missile interceptors, and Battle Management, Command, Control and Communications.

Prior to development and deployment, any SDS must demonstrate an ability to meet the requirements of military effectiveness, survivability, and cost effectiveness. The focus of the research into SDS/Phase I elements is to develop Phase I technologies which can meet these requirements. We are encouraged by our progress.

Cost reduction has long been recognized as an important component of the SDI program, and cost-reduction efforts have been emphasized in tandem with technology research. By anticipating potential SDS costs, and by implementing technology development strategies that focus on reducing costs, we believe the SDS will be affordable. As Lieutenant General Abrahamson testified last October to the joint committees on Armed Services, the current estimate of the total cost to demonstrate, validate, develop and deploy the first phase of a SDS is $69 billion. This figure is a substantial cost reduction from earlier estimates, and we expect even further reductions as architecture refinements, new manufacturing techniques and other improvements are made. The reduction to $69 billion was achieved largely through eliminating unnecessary redundancy, increased space-based interceptor performance (resulting in the need for fewer interceptors), and from more capable sensor technology and design. We will continue efforts to both develop systems which are cost effective and seek trade-offs where possible to reduce overall investments.

I would like to review for this Committee the major, mature technologies/system elements which could make up an effective defensive system. The hardware specifications for such an initial defensive system, Phase I, are not absolutely fixed; as continued progress is seen in the demonstration/validation effort, and in technology development, we may substitute or add more promising technology.

SENSORS

Boost Surveillance and Tracking System (BSTS). The BSTS is a missile launch warning system to detect launches of ICBMs and SLBMs. The sensors in BSTS satellites detect and track infrared emissions of a missile's propulsion system. Technology programs, ground demonstrations, and measurement programs are in process and focus on developing a complete understanding of the phenomenology and system design requirements. Ground demonstrations are scheduled to support both a system design selection and a full scale development decision in mid-year 1990. Currently, two contractors are finalizing their individual system design concepts. The first BSTS deployment is planned for the mid-1990s.

Space-Based Surveillance and Tracking System (SSTS). The SSTS is a constellation of satellites and ground stations. The primary sensing payloads of the satellite are a Long Wave Infrared (LWIR) passive sensor and a visible/ultraviolet passive sensor. The primary mission of SSTS is to track Post-Boost Vehicles (PBVs), target clusters, and Anti-Satellite Weapons (ASATS) to support defensive weapon engagement. The SSTS will also be able to track and discriminate a small number of RVs and perform foreign target signature collection and satellite tracking functions. The SSTS may provide weapon target assignment, fire control and inflight updates for Space Based Interceptors during post boost and early midcourse phases of flight. Initial design validation will be accomplished by an end-to-end ground demonstration scheduled for 1992 and will be the basis for downselection to a single contractor who will

produce the satellite.

Ground-Based Surveillance and Tracking System (GSTS). The GSTS is a fast-response, two stage, rocket-launched long wavelength infrared (LWIR) sensor system boosted into suborbital flight for use in the midcourse phase. The GSTS sensor operation is integrated with SSTS and GBR operations to provide track and discrimination. GSTS sensors are launched on selective trajectories based on early attack assessment data provided by the BSTS, SSTS, and other early warning sensors. The GSTS sensors would not be committed until the threat is launched to provide best GSTS inventory usage to increase the overall effectiveness of the SDS. GSTS enhances strategic defense robustness by providing a reconstitution capability in the event of an SSTS outage, to fill gaps in SSTS coverage, and to augment SSTS viewing in high density traffic situations.

A single contractor is developing concepts and multiple sensor designs. Sensor design will be selected based on technology experiments and sensor test bed results. A flight-qualified payload design will be developed and then fabricated for hardware-in-the-loop ground test demonstrations in FY92.

Ground-Based Radar (GBR). The Ground-Based Radar -Experimental (GBR-X, formerly named the Terminal Imaging Radar) is a phased-array, technology demonstration radar to be used for experiments at the U.S. Army Kwajalein Atoll for multi-target acquisition, tracking and discrimination in the midcourse and high endoatmospheric phases. It will accept hand-over from other midcourse sensors. The previous radar design was modified

in 1988 to operate in the midcourse region. This design facilitates integration with both ground and space based interceptors. The follow-on Ground-Based Radar program will develop a tactical, late midcourse defense radar to meet the ballistic missile threat, as an deployment system option for the SDS.

DEFENSIVE INTERCEPTORS

Ground-Based Interceptor (GBI). The GBI is an exoatmospheric interceptor to perform preferential and adaptive defense of selected targets. A Demonstration/Validation flight test series is intended to demonstrate, in FY 90-91, a LWIR seeker against a representative target complex (including decoys and countermeasures). Preparations are being made to develop and integrate the advanced technology required for engineering development. We plan to flight test these technologies in the 1991-92 time frame.

Space-Based Interceptor (SBI). SBI obtains the maximum defense leverage by intercepting boosters and post-boost vehicles before they have a chance to deploy reentry vehicles and clouds of decoys. SBI also has the additional capability to intercept re-entry vehicles and anti-satellite weapons, as the threat changes, with increased defensive benefits. Although the present architecture calls for SBIs to be garaged in groups of ten, the interceptors could be deployed as free flying "singlets" as proposed in the "Brilliant Pebbles" concept, with modification to battle management and surveillance requirements.

Technology simulation and tests are in progress to support the optimization of a low cost SBI. In particular, hover

testing at Edwards Air Force base and Sensor/Sensor Processor testing at Eglin Air Force Base in FY89 and FY90 will investigate the bounds of interceptor performance. These ground tests will be augmented, in the FY90 to FY92 period, with ballistic tests of SBI subcomponents at the White Sands Missile Range. In FY93, ballistic intercepts will be conducted at the Kwajalein Missile Range. These tests will complete preparation for a Full Scale Development Decision in FY94.

BATTLE MANAGEMENT/COMMAND, CONTROL, COMMUNICATIONS

This component has been designated the Command Center/System Operation and Integration Functions (CC/SOIF). The Command Center element will provide positive, survivable, and secure human control over the SDS. It will consist of fixed and mobile units and a terrestrial communications network with ground entry points for interconnectivity to the space components. CC also supports coordinated offense-defense operations and interfaces with other U.S. government agencies.

The System Operation and Integration Functions include the distributed information processing network needed for the automated execution of a human-selected battle plan. This requires both the assured, secure exchange of information between the CC and all SDS elements, and the data processing to identify targets, allocate weapons, execute the defense and assess its success, and manage the system's resources.

A baseline CC/SOIF architecture has been identified, with automated decision functions allocated to interceptor and sensor elements. Software policy, based on the recommendations of the Defense Science Board, emphasizes standardization,

supportability, risk reduction, security, reusability, and documentation.

In the coming year, the CC/SOIF program will:

- Develop a pilot Command Center experiment to resolve issues,

- Develop and refine Sensor Planning Algorithms for the Phase I design,

- Conduct advanced CC/SOIF simulations to test integrated system operations,

- Refine the content of ongoing experimental activities,

- Accelerate the use of available data from multiple experiments.

An Experimental Version of the CC/SOIF element should be available in FY 1994, with prototype CC/SOIF participating in realistic integrated tests with other SDS elements beginning in FY 1996.

ADVANCED TECHNOLOGIES.

Subsequent deployments, necessary to maintain and improve the initial defensive system capability, may include some or all of the following major candidate systems, depending on the threat response and the technological progress. Or, if more promising, one of these could be moved to the initial phase. There are still many unknowns associated with these technologies and a significant investment is necessary to resolve the unknowns.

Singlets. The concept of a singlet, in which the total surveillance is built into the interceptor, is embodied in a concept called Brilliant Pebbles. This interceptor would be

completely autonomous. Given a release command, the interceptor would use its own sensors to acquire a target and engage it without external tracking data or other assistance.

The interceptor should be low cost because it is derived from pervasive use of miniaturized commercial and military "off-the-shelf" high technologies, including miniaturized high-resolution/wide-field-of-view video imaging systems that work from the mid-UV to the mid-IR range, a super computer with Cray-I performance operating off high-energy-density "D-cell" sized batteries, a miniaturized high-power laser imaging radar/communications system, and a high-mass monopropellant propulsion system.

This interceptor's passive features -- small size, low cost, autonomy, and dispersal ability as singlets -- would be jam resistant, provide low-detection cross section, enable interceptors to be supplemented by decoys, and provide low value per individual target. These features would be supplemented by a full nuclear survivability suite and extensive maneuver capability for breaking track, evasion, and antisimulation in conjunction with constellation decoys.

High Endoatmospheric Defense Interceptor (HEDI). HEDI is a hypervelocity missile with a non-nuclear warhead that provides endoatmospheric (terminal phase) defensive coverage against ICBMs and SLBM RV's. The contribution of HEDI to the SDS architecture would be an additional defensive layer to further reduce RV leakage rates. The HEDI research is focused to resolve technology issues dealing with aero-optical effects, window and forebody cooling, shroud removal, non-nuclear warhead

kill and guidance and controls. The FY90 request supports the second major flight experiment (KITE-1) in which the IR passive seeker will be demonstrated, and several key ground tests to obtain significant optical and thermal data. The HEDI project is probably the most mature follow-on element and could enter into Demonstration/Validation (a Milestone I decision) in FY 90, if required.

Neutral Particle Beam (NPB). Orbiting stations would produce beams of neutral particles sufficient to destroy boosters and reentry vehicles, and provide interactive discrimination between warheads and decoys. A Milestone I decision is planned in the early 1990s, with a Milestone II decision in the mid-1990s.

Space Based Laser. Orbiting stations would produce laser beams sufficient to destroy boosters, post-boost vehicles, provide interactive discrimination, and provide self-defense capability for SDS elements. A Milestone I decision is planned for early 1992, with a Milestone II decision in the mid-1990s.

Ground Based Free Electron Laser (GBFEL). Protected sites in the United States would produce high energy laser power, relayed through space by mirrors, sufficient to destroy boosting missiles and to provide interactive discrimination. A Milestone I decision is planned for the early 1990s, with a Milestone II decision in the mid-1990s.

There are many other components of the SDI research effort, each with a supporting series of technology base research and experiments. Examples are the many sensors, processors and control elements associated with the sophisticated acquisition,

tracking, pointing and fire control necessary to orchestrate the multiple autonomous functions of the directed energy systems. We have attempted to detail in the Report to Congress the complete extent of the research.

The Report to Congress on the SDI program also contains information regarding SDI's compliance with the ABM Treaty. As has been the case since the SDI program inception, planned tests and experiments for fiscal years 1990-91 are in full compliance with the ABM Treaty. All tests are reviewed in detail by the Department of Defense (DoD) Compliance Review Group to assure such compliance. This review process is a deliberate, vigorous study of plans and treaty consideration.

Last year's Defense Authorization Act (Section 224) required a report on the feasibility of an accidental launch protection system. As you are aware, the Administration is conducting a comprehensive strategic review. The Department is very actively involved in that review, which includes consideration of the optimal SDI program. The Report on ALPS will be submitted as soon as possible upon completion of that review.

I would like to touch briefly on one other item before I proceed to highlight our technical progress this past year. You may be aware that the SDI research involves our Allies. The President's original guidance and SDI's charter reflected a concern for both U.S. and Allied security and stressed the development of ballistic missile defense technologies for threats of all ranges. Most of our Allies support the SDI research effort and, within the established DoD competitive

contracting procurement procedures, are actively participating with valuable technical contribution to the program. Since, SDIO's mandate extends to examining technologies for theater missile defenses, the Fiscal Year 1990 program will include analyses, technology developments and experiments that will improve our understanding of the theater defense problem. Technical programs include hypervelocity gun experiments, radar analyses, lethality studies, and theater test bed development. In several cases, our Allies are working cooperatively with us as we proceed in this area. A notable experiment will be the U.S./Israeli missile engagement experiment titled ARROW.

SDI research accomplishments have increased our confidence that strategic defenses will prove feasible. In past years, the SDI Organization has conducted a series of kinetic energy and directed energy weapon technology tests. Kinetic energy tests have successfully demonstrated the capability to intercept and destroy -- by non-nuclear means -- enemy ballistic missiles before they reach their targets. The first of a series of "hover tests" of a space-based interceptor have been conducted in a ground test facility. These tests help evaluate the capability of fast acting thrusters to keep a sensor pointed at a target, and the interaction of the sensor and guidance systems. This past year the Aerothermal Reentry Experiment (ARE) demonstrated that kinetic energy weapons can destroy warheads not only with a perfect hit, but also by inflicting damage with a less than perfect collision. ARE demonstrated the process of self-destruction of a damaged warhead as it enters the atmosphere. We will continue work over the next two years

toward integrated flight tests which will demonstrate with sufficient confidence that ground-and space-based interceptors can in fact satisfy the requirements for the first phase of a defensive system.

With directed energy experiments, researchers have demonstrated several key principles related to the operation of a large Free Electron Laser, a weapon which could become powerful enough to destroy enemy ballistic missiles in the boost and post-boost phases of flight. The Free Electron Laser has demonstrated lasing which shows wavelength scaling beyond that needed for an operational defense system. Similar experiments are also being conducted using other types of lasers and neutral particle beams. While lasers and particle beams will not be available as soon as some of the kinetic energy systems, their importance to the overall SDI mission cannot be overstated. Although such systems would build on the capability of an initial system, they would have at least one new mission: to thwart the effectiveness of a new generation of Soviet ICBMs and other possible counters to an SDS. Kinetic energy systems, lasers, and particle beams form what might be considered a mutually reinforcing "triad" of defensive systems much like the mutually reinforcing and complementing aspect of the offensive Triad. Additionally, by following the system design approach which we call "branch and block," we can frustrate threat evolution by maintaining an ever present capability to expand the SDS to meet the threat.

We have continued to exploit the successes of earlier experiments which demonstrated substantial improvements in our

ability to develop sensors necessary for strategic defenses. Last year's DELTA 181 experiment provided valuable information on the signatures of midcourse targets. The assortment of active and passive sensing instruments accurately characterized the test objects, and also the launch of a research rocket, in a variety of space environments. This data is being used to develop effective algorithms for discrimination between decoys and reentry vehicles.

Some surveillance and sensor technologies supported by the SDI program address not only SDI but other critical national security needs as well. The capabilities of today's early warning radars and satellites could be greatly improved through advancements in detection capabilities. New sensors will provide more accurate and reliable surveillance data of objects in space.

Tangible, impressive results have given us increased confidence that strategic defenses are feasible. Our progress has been excellent but we still have much left to do. Unanswered technical issues exist even though we are making great strides in fully understanding strategic defenses. The principal uncertainties of ballistic missile defense have been recognized for several years; these center around three issues: 1) assured survivability of space-based elements, 2) early interception of boosters and post-boost vehicles, and 3) discrimination. We have programs actively pursuing resolution of each of these issues.

Our schedule for the next two years includes a number of very important tests and experiments. Again, each of these is



98-110 O - 89 - 18

fully compliant with all treaty obligations. I would like to briefly highlight a few upcoming projects and experiments, their contribution to the research program and the issues which will be addressed (from the three listed above).

| Experiment | Objective | Issues Addressed |
|---|---|---|
| Delta Star | Collect multispectral imagery of rocket plumes and the near-space environment. | 2, 3 |
| Beam Experiment Aboard Rocket (BEAR) | First test of a Neutral Particle Beam in space. | 1, 2, 3 |
| Laser Atmospheric Compensation (LACE), Relay Mirror (RME), Experiment | Space test of relay mirror and atmospheric compensation process for ground based free electron laser. | 1, 2 |
| STARLAB | Space test of tracking/ pointing, sensor and communication technologies. | 1, 2 |
| Space Power Experiment Aboard Rocket (SPEAR) II | Space test of high power electricity applications. | 2 |
| Airborne Optical Adjunct Infrared Experiment | Airborne test of LWIR sensor. | 2, 3 |

The budget request supports both Phase I and technology for follow-on phases. Phase I elements are currently in the Demonstration/Validation phase of the Defense Acquisition process and will enter Full Scale Development in the next 3-4 years. This system will support the minimum requirements, established by the Joint Chiefs of Staff for a strategic defense system that has military utility. Subsequent phases will build on that system, as necessary, to maintain military utility.

I am happy to answer any questions you may have.

# HASC TESTIMONY

**14 MAR 89**

**Lt Gen George L. Monahan, Jr.**
**Director**
**Strategic Defense Initiative Organization**

# SDIO OBJECTIVES

As Set Forth In DoD Directive 5141.5 "Strategic Defense Initiative Organization", Original Dated 21 Feb 86

- Conduct Vigorous Research Program To Develop Key Technologies For Defense Against Ballistic Missiles
- Consider Options To Increase The Contribution Of Defenses To US And Allied Security
- Protect Options For Near-Term Deployment Of Limited Ballistic Missile Defense
- Carry Out Program In Full Consultation And, Where Appropriate, With Participation Of Our Allies

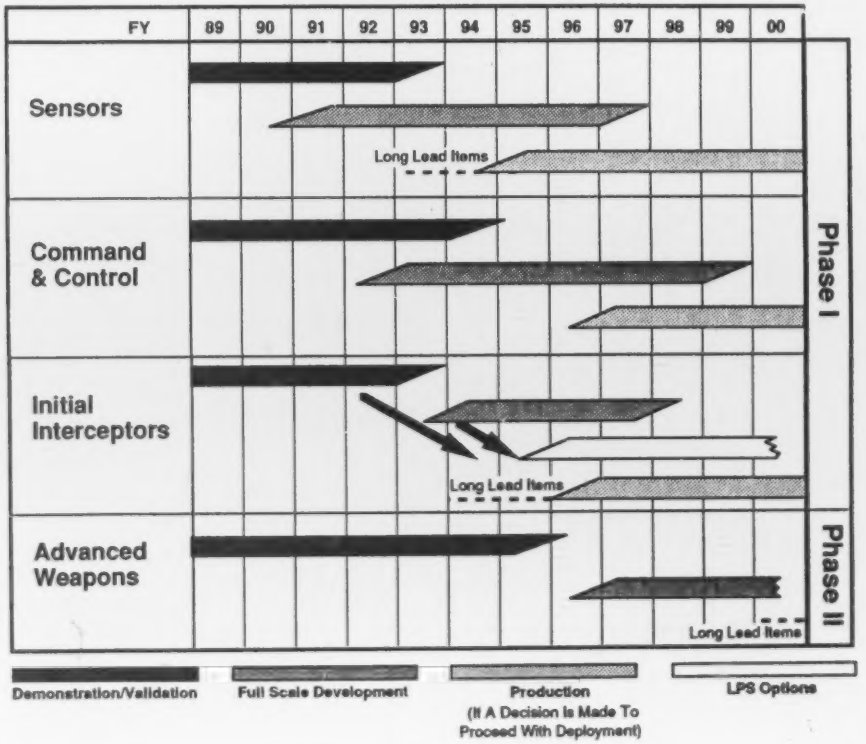
540

jm-0598

# CURRENT PROGRAM STRUCTURE

- Based On SDI Charter And JCS Requirement
- Defense Acquisition Board (DAB), October 1988
  - Multi-Phased Program
  - Phase I To Proceed Into Demonstration / Validation Phase
  - Subsequent Phases To Be Addressed At Later DABs

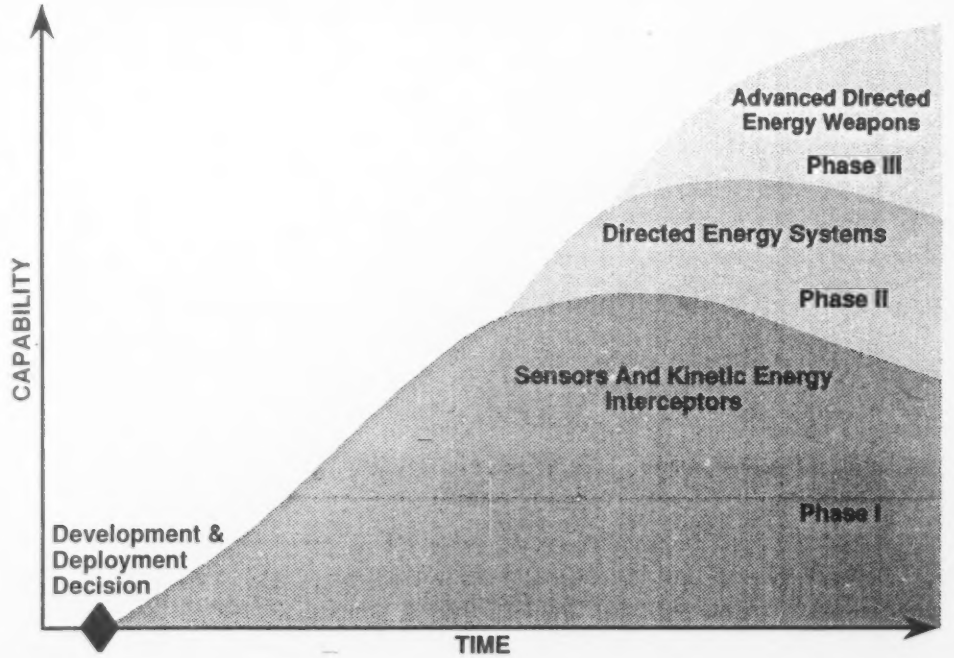
# SDS PROGRAM SCHEDULE
## (Oct 88 DAB)






jm-0857

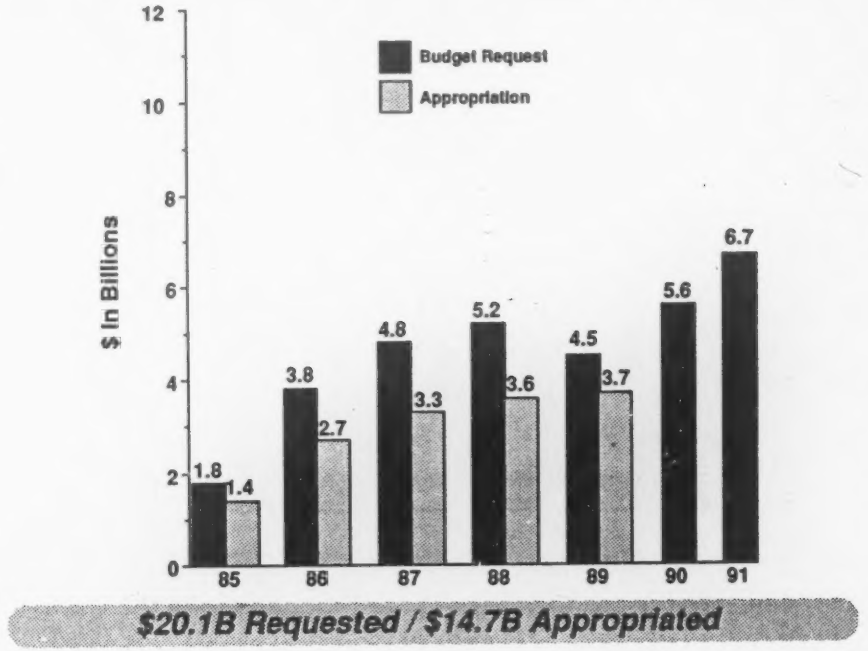
# THE PATH TO "THOROUGHLY RELIABLE" DEFENSES






jm-0658

# SDIO BUDGET

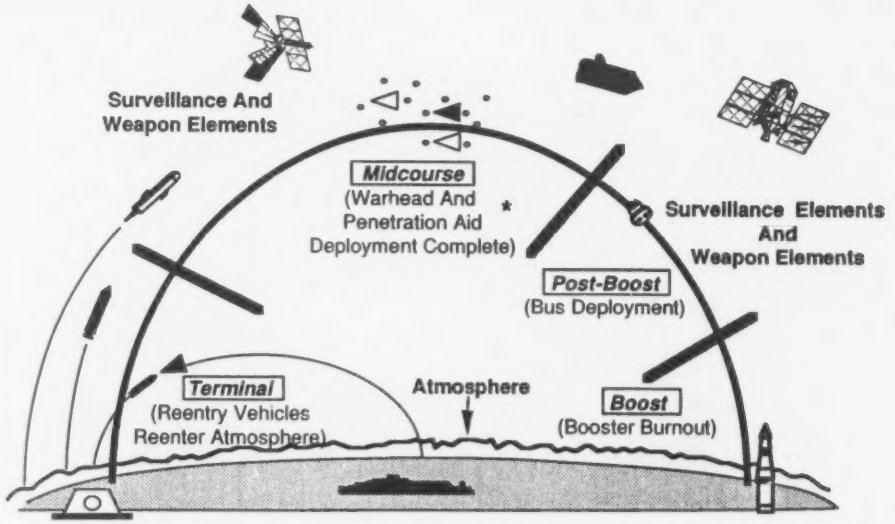



**$20.1B Requested / $14.7B Appropriated**



jm-0559

# SDS PHASE ONE ARCHITECTURE




***We Are Building A System***



jm-0560

# SDS PHASE ONE PROGRAM

## Major Elements

BSTS - Boost Surveillance And Tracking System

SSTS - Space Surveillance And Tracking System

GSTS - Ground-Based Surveillance And Tracking System

GBR - Ground Based Radar (Pending)

CC - Command Center

GBI - Ground-Based Interceptor

SBI - Space-Based Interceptor

# BOOST SURVEILLANCE & TRACKING SYSTEM

**Functions**

- Surveillance - Continuous Global Observation Of The Earth's Surface
- Detection - ICBMs, IRBMs, SLBMs
- Acquisition - Initiate Tracking Of Missiles
- Tracking - Compute State Vectors And Predict Future Positions
- Typing - Determine The Missile Type
- Kill Assessment - Provide Data To Assist In Determination Of A Hit Or Kill
- Communications - Transmit Required Data To All Users
- Battle Management - As Determined By The SDS Architecture

**Characteristics**

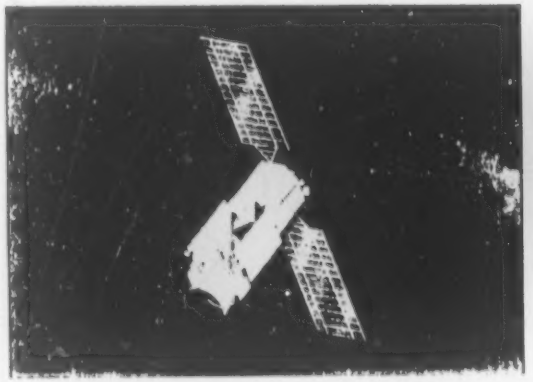
| | |
|---|---|
| Size: | Approx. 36 x 16 Ft. |
| Bands: | Multispectral |
| Sensor: | Scanning Or Staring |
| Power: | 6 - 10 Kw |
| Total Spacecraft Weight: | 5000 - 7000 Kg (11,000 - 15,400 Lbs) |



jm-0513

# CURRENT SPACECRAFT CONCEPTS

GRUMMAN

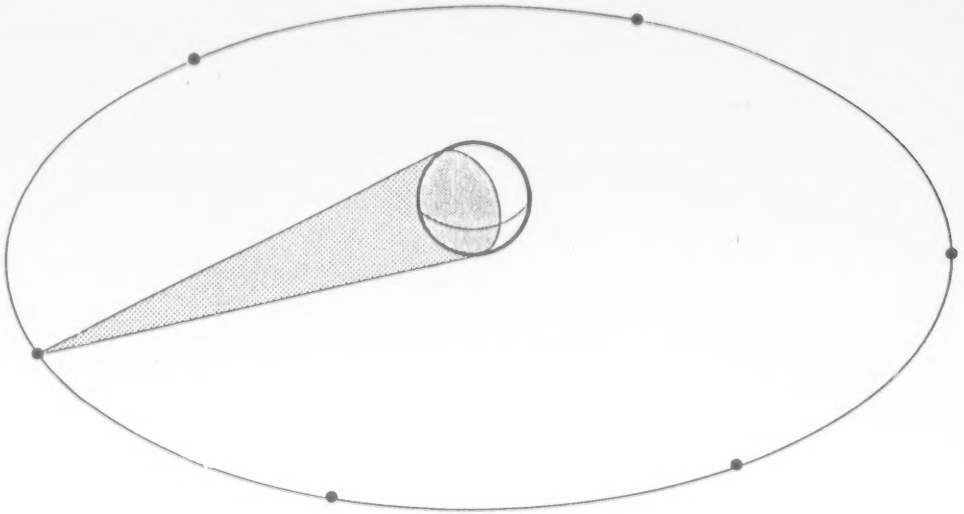


LOCKHEED

VG 87U-1008/1
10 Feb 89

UNCLASSIFIED

# NOTIONAL BSTS COVERAGE



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# SPACE SURVEILLANCE & TRACKING SYSTEM

**Functions**

- Acquire And Track ASATs, PBVs, And RVs
- Fire Control For SBI
- Handover Unresolved Clusters To GSTS And GBR
- Space Surveillance Worldwide
- Foreign Target Data Collection

550

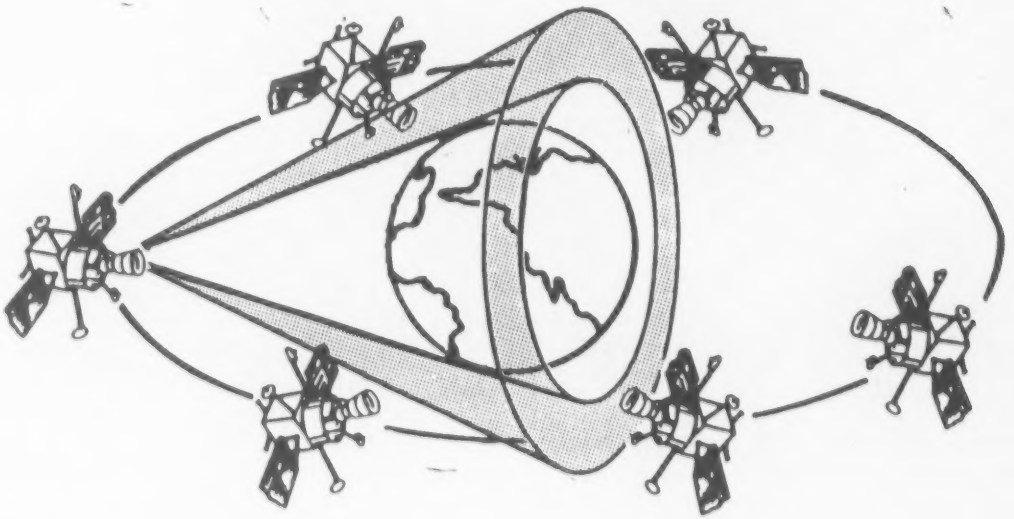
**Characteristics**

| | |
|---|---|
| Aperture: | < 1.0 Meter |
| Sensor: | Scanning |
| Revisit Time: | < 10 Sec |
| No. Of Detectors: | $< 10^5$ |
| Bands: | Multispectral |

# SPACE SURVEILLANCE AND TRACKING SYSTEM (SSTS)

Vu 87-11-0245-2
7 Feb 89

# SPACE SURVEILLANCE AND TRACKING SYSTEM (SSTS)



# GROUND-BASED SURVEILLANCE & TRACKING SYSTEM

**Functions**

- Track And Discriminate RVs From Penaids
- Reconstitution Of Space Surveillance Capability Due To Attrition
- Acquire & Track Low Altitude SLBMs

553

**Characteristics**

| | |
|---|---|
| Aperture: | < 1.0 Meter |
| Sensor: | Scanning |
| Revisit Time: | < 10 Sec |
| No. Of Detectors: | $< 10^5$ |
| Bands: | Multispectral |

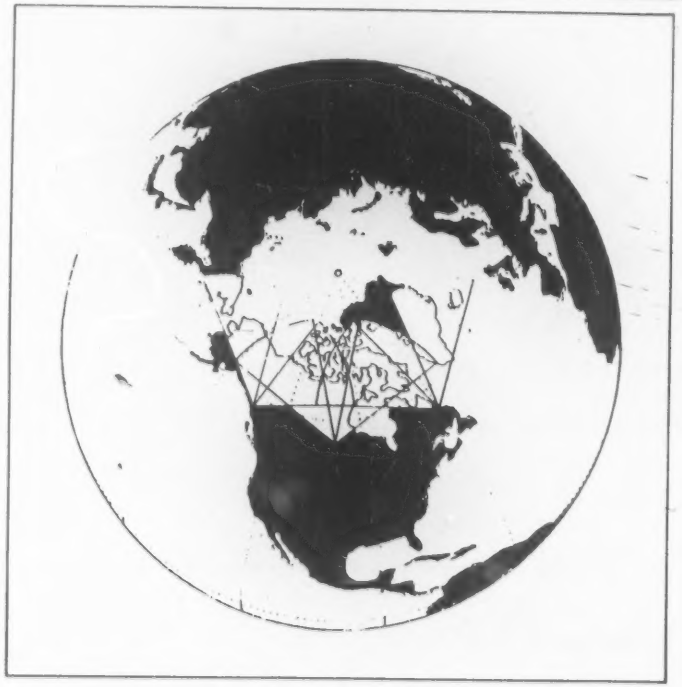


jm-0815

# GROUND-BASED SURVEILLANCE AND TRACKING SYSTEM (GSTS)

VG 88 U 1019 1
10 Mar 89

# GSTS COVERAGE



# GROUND-BASED RADAR

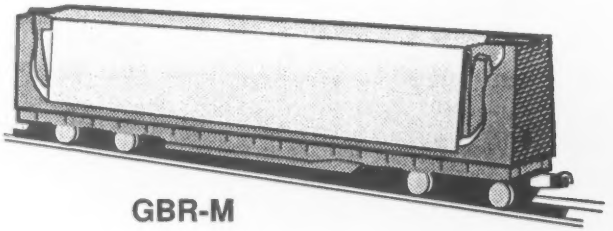
**Functions**

- Acquire, Track & Discriminate RVs In The Presence Of Decoys
- In-Flight Guidance To Space And Ground-Based Interceptors
- Kill And Damage Assessment

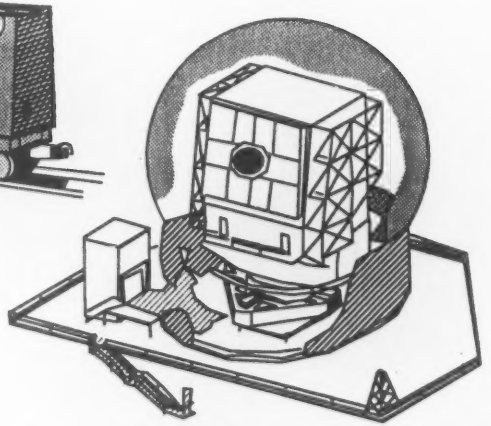
**Characteristics**

- X-Band Phase Array Radar
- 290,000 Phase Shifters
- High Precision Range Resolution
- Rail Mobile Or Fixed Based

# GROUND BASED RADAR



GBR-M



GBR-X



jm-0542

# COMMAND CENTER

**Functions**

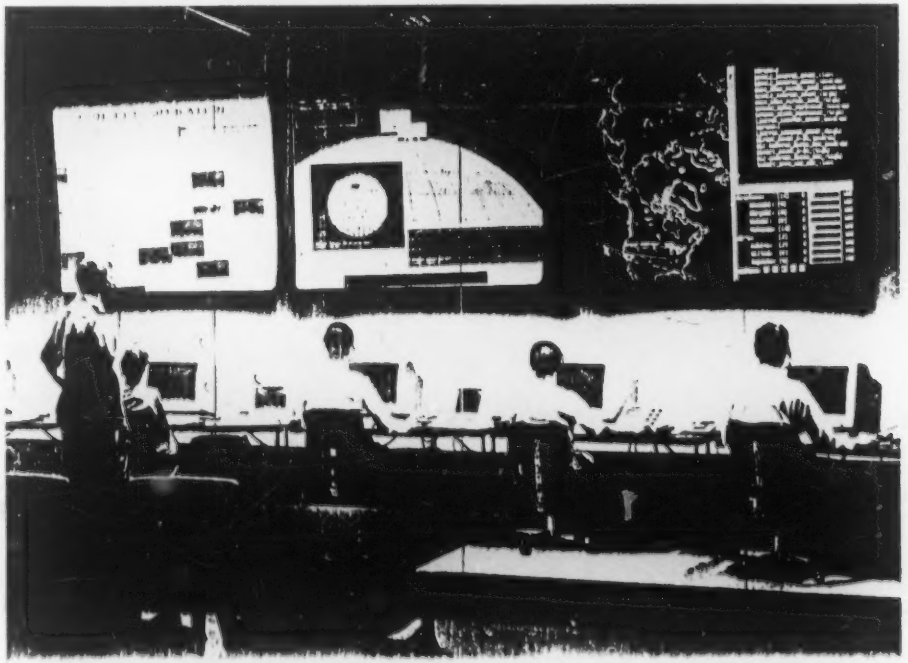
- "Man-In-Control"
- Global Attack Assessment
- Battle Plan Execution
- Real-Time Support To Other Warfighting CINC's
- Strategic Defense Reconstitution

**Characteristics**

- Fixed And Mobile Command Centers
- Robust Space And Ground Communiucation & Data Networks
- Multiple Interfaces With Unified & Specified CINC's

UNCLASSIFIED

# EV-88 SIMULATION



UNCLASSIFIED

# GROUND-BASED INTERCEPTOR

**Functions**

- Intercept RVs In Midcourse
- Provide Terminal Target Lock-On In Countermeasure Environment
- Provide For Adaptive & Preferential Defense Of Blue Forces And Targets

**Characteristics**

- Low Cost
- Lightweight: ~700 Kg (1540 Lbs)
- Hit-To-Kill
- "Dormant" Missile Concept

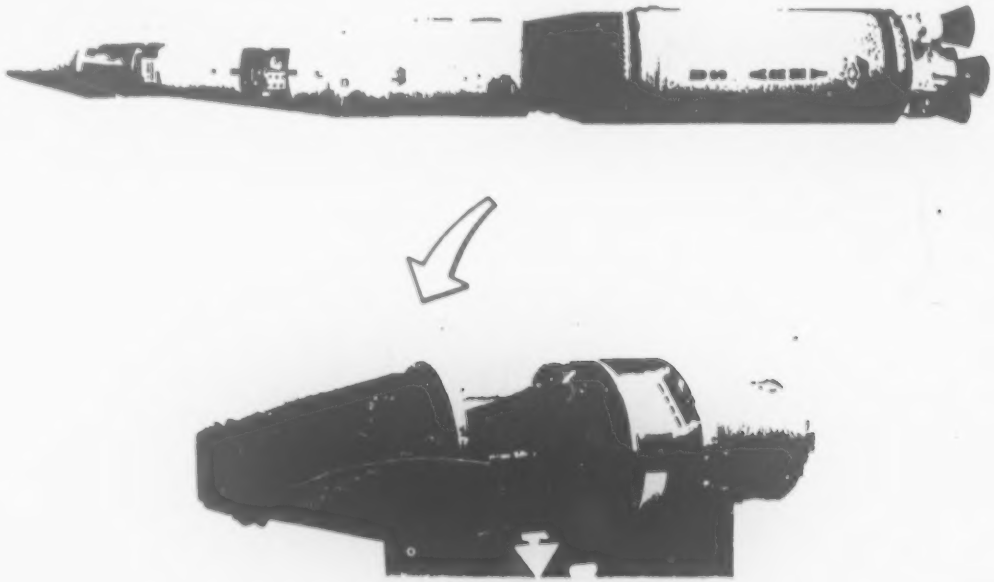


jm-0563

560

UNCLASSIFIED

# GROUND-BASED EXPERIMENTAL INTERCEPTOR



UNCLASSIFIED

# SPACE-BASED INTERCEPTOR

**Functions**

- Destruction Of Boosters, PBVs, RVs And ASATs In The Boost, Post-Boost And Midcourse Phases
- Target Lock-On And Steering During Terminal Phase Of Intercept

**Characteristics**

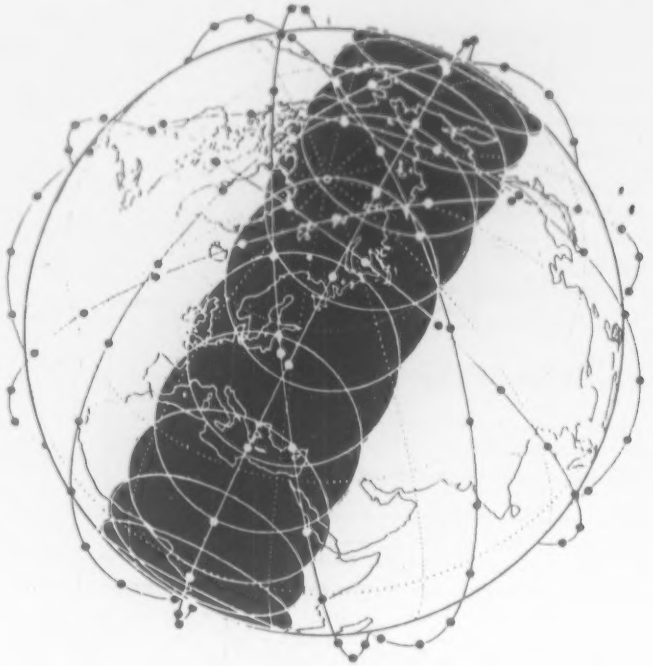
- Carrier Vehicle — 3000 Kg (6600 Lbs)
- Interceptor — Low Cost / Long Life
- Hit-To-Kill

562



jm-0564

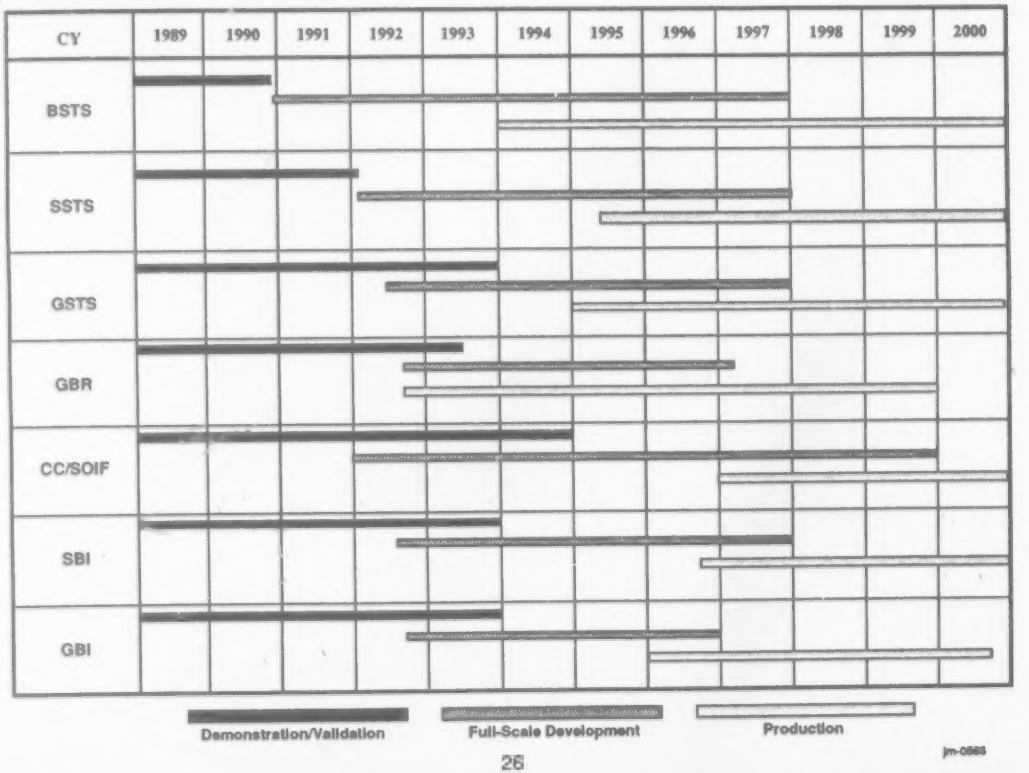
# SBI COVERAGE





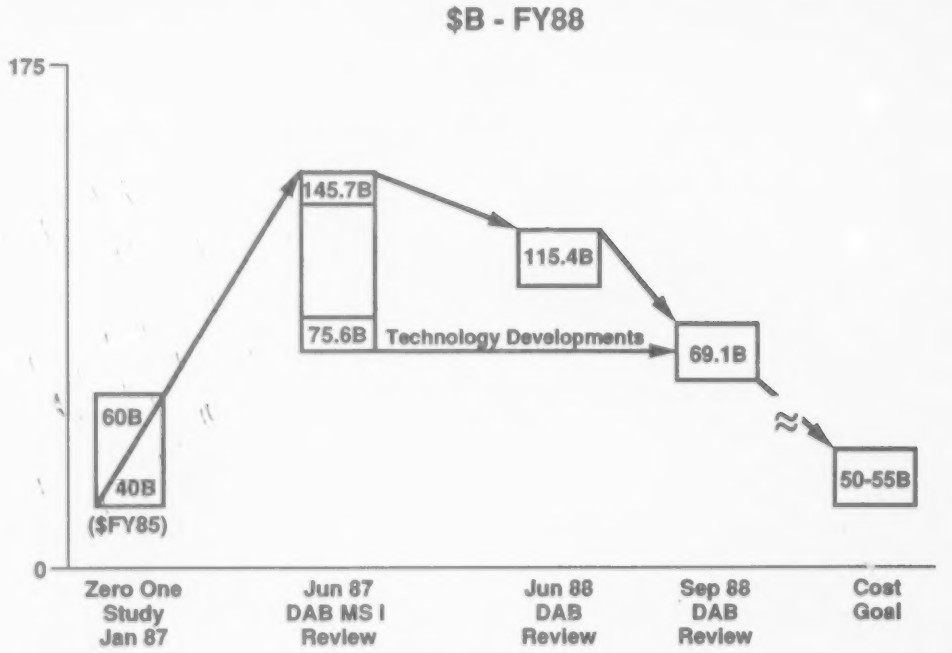
BMO 0120
2 Feb 89
0739

# SDS DAB PROGRAM




jm-0565

# SDS ACQUISITION COST EVOLUTION






jm-0887

# BRILLIANT PEBBLE CONCEPT - SBI

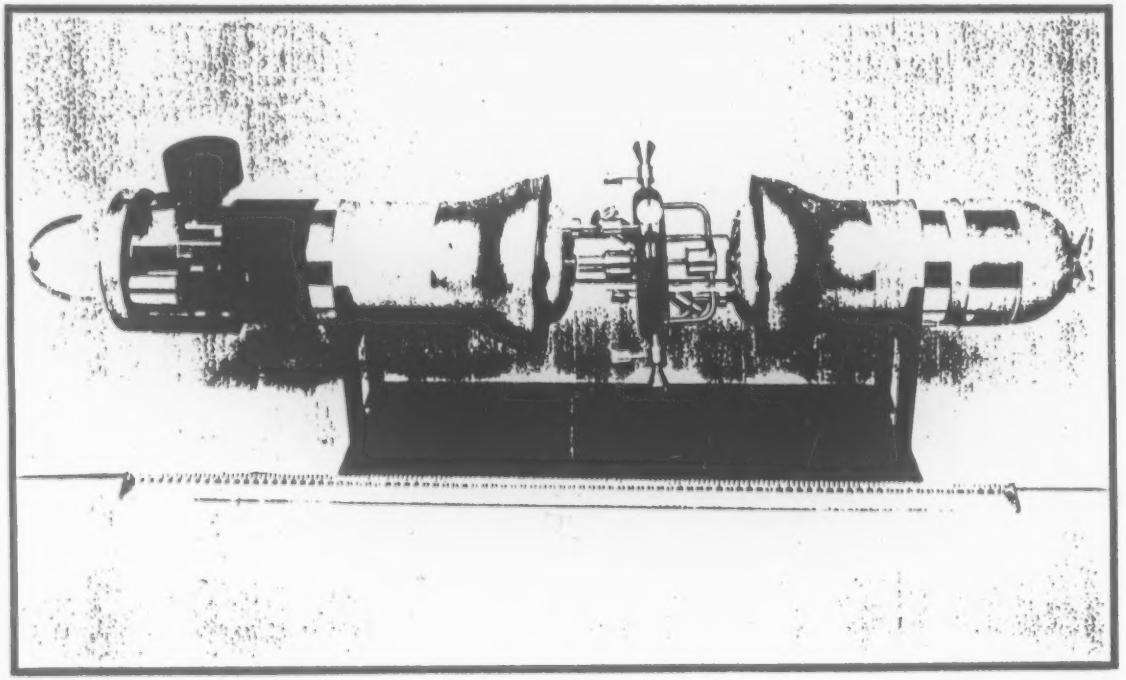
Functions

- Destruction Of Boosters And PBVs
- Surveillance And Target Acquisition
- Laser 2-Way Communications

Characteristics

- Interceptor Orbits In Protective Shell / Life Jacket
- Low Cost / Light Weight (88 Lbs)
- Highly Survivable Singlets
- Hit-To-Kill

# BRILLIANT PEBBLES (U)



89C.0108
7 Feb 89

# FOLLOW-ON SYSTEMS

HEDI - High Endoatmospheric Defense Interceptor

SBL - Space Based Laser

NPB - Neutral Particle Beam

GBL - Ground Based Laser

98-110 O - 89 - 10

# HIGH ENDOATMOSPHERIC DEFENSE INTERCEPTOR

Functions

- Performs High Endoatmospheric Intercept (Terminal Defense Layer)
- Accepts Both Gound-Based And Midcourse Sensor Commit
- Acquires, Homes On, And Destroys An RV With A Non-Nuclear Kill Warhead
- Provides Defense Against Short Flight Time / Depressed Trajectories

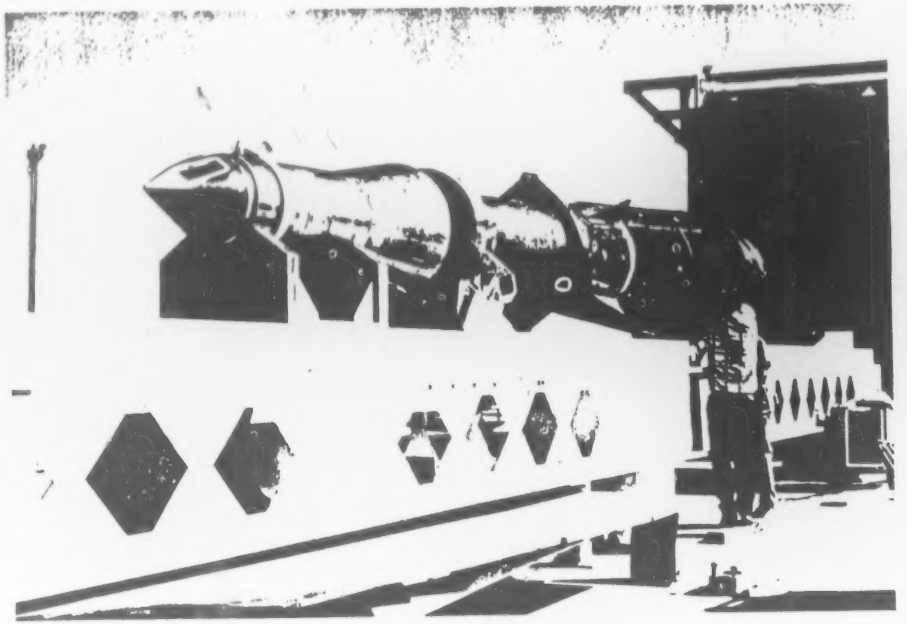
Characteristics

- Kill Vehicle Weight <170 Kg (90 Lbs)
- Battlespace Altitude >70 Km (38 nm)
- IR Passive Seeker

569

UNCLASSIFIED

# HEDI AT WHITE SANDS



UNCLASSIFIED

89U 0375
8 Mar 89

# SPACE-BASED LASER

Functions

- Intercept Boosters And PBVs
- Capability For Surveillance, Detection And Track Of Boosters, PBVs And RVs

Characteristics

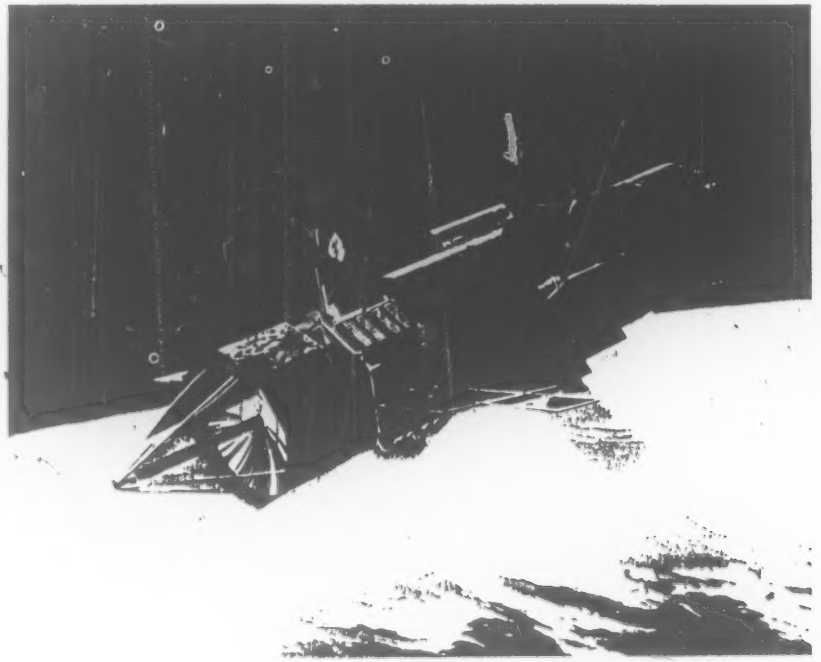
- Speed-of-light Delivery
- Rapid Retargeting
- Multispectral Sensors With Very Large Aperture Collectors
- Weight: 220,000 Lbs

571



jm-0571

# ZENITH STAR



# NEUTRAL PARTICLE BEAM

Functions

- Destroy Boost And Post Boost Vehicles
- Discriminate RV's From Decoys

Characteristics

- Rapid Retargeting / Multiple Shot Capability (17 / Sec)
- Operates In Hostile Nuclear Environment
- Kills Target By Indepth Penetration
- 116,000 Lbs Weight 120 Ft Length



jm-0672

573

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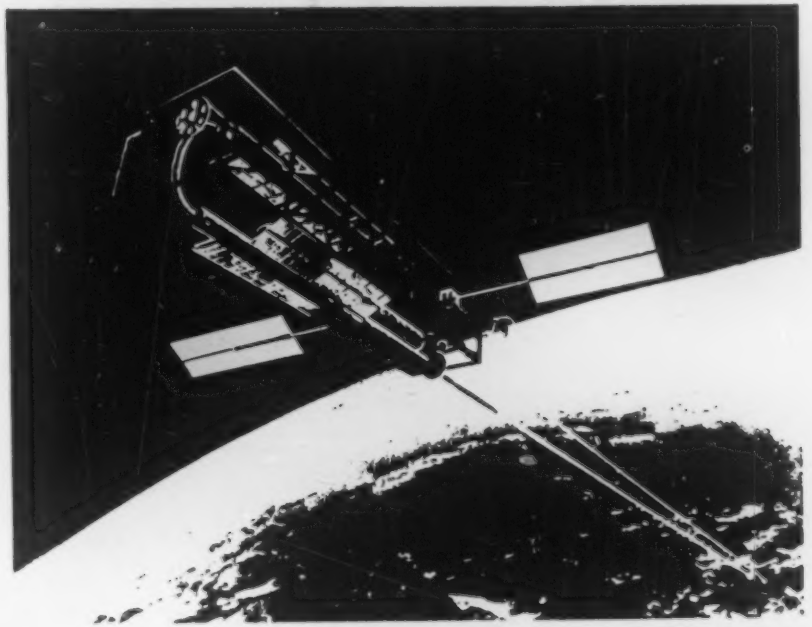
# NEUTRAL PARTICLE BEAM SPACE EXPERIMENT



UNCLASSIFIED

# GROUND-BASED LASER

Functions

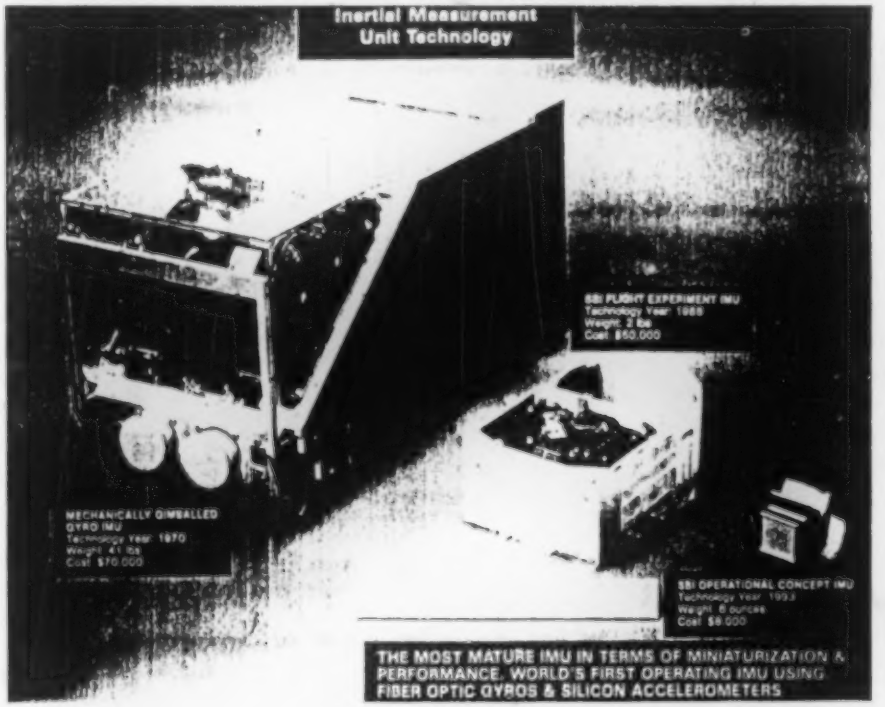
- Destroy Boosters And Post Boost Vehicles
- Discriminate Light Decoys From RV's
- Capability For Surveillance And Track

Characteristics

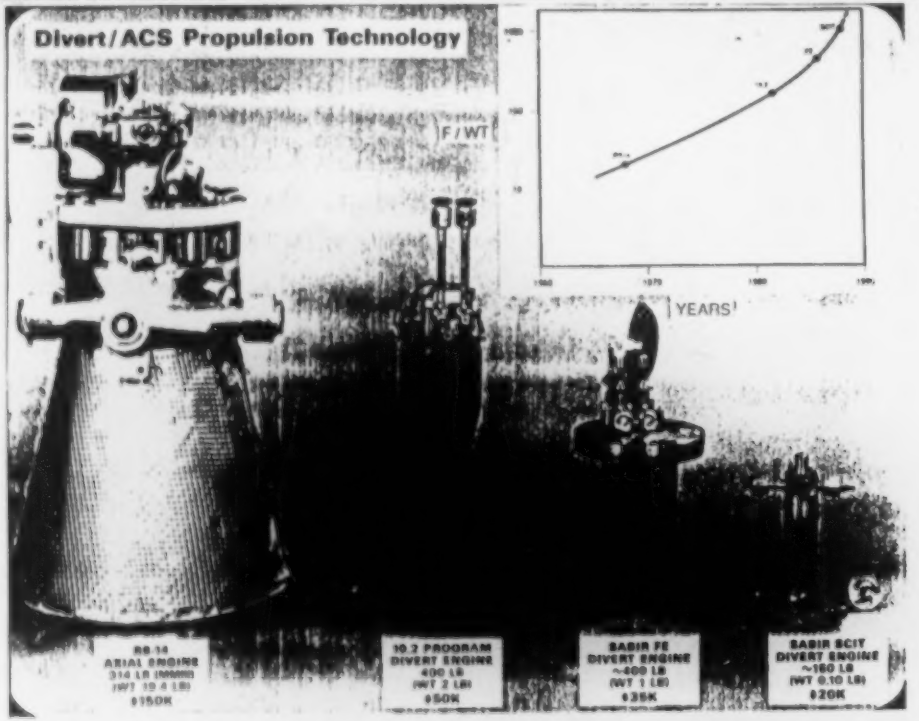
- Speed-of-light Delivery Into Atmosphere
- Rapid Retargeting
- Infinite Magazine
- Multispectral Sensors With Large Apertures
- Multiple Ground Sites To Avoid Clouds

GROUND-BASED LASER

# INERTIAL MEASUREMENT UNIT TECHNOLOGY

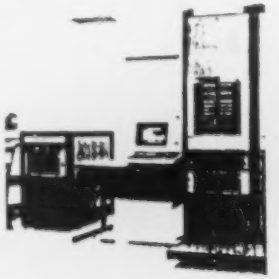
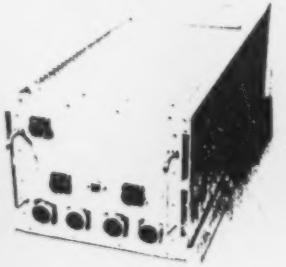
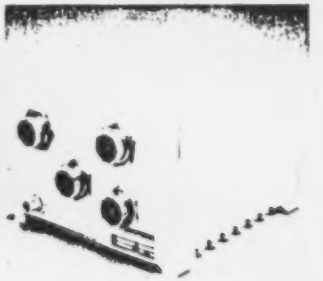

Inertial Measurement Unit Technology
SBI FLIGHT EXPERIMENT IMU
Technology Year: 1988
Weight: 2 lbs
Cost: $50,000
MECHANICALLY GIMBALLED GYRO IMU
Technology Year: 1970
Weight: 41 lbs
Cost: $70,000
SBI OPERATIONAL CONCEPT IMU
Technology Year: 1993
Weight: 6 ounces
Cost: $8,000
THE MOST MATURE IMU IN TERMS OF MINIATURIZATION & PERFORMANCE. WORLD'S FIRST OPERATING IMU USING FIBER OPTIC GYROS & SILICON ACCELEROMETERS

# DIVERT/ACS PROPULSION TECHNOLOGY



UNCLASSIFIED

# SPACE PROCESSOR EVOLUTION

| | ADVANCED DISTRIBUTED ONBOARD PROCESSOR | AIRBORNE SURVEILLANCE TEST BED | GENERIC VHSIC SPACEBORNE COMPUTER |
|---|---|---|---|
| |  |  |  |
| SIZE | 4.5 FT³ | 2.0 FT³ | 0.25 FT³ |
| WEIGHT | 130 LB | 130 LB | 12 LB |
| POWER | 1 kW | 1 kW | 80 W |
| ENVIRONMENT | LAB | FLIGHT | SPACE |
| THROUGHPUT | 3 MIPS | 3 MIPS | 15 MIPS |
| RADIATION HARDNESS | NON RAD-HARD | NON RAD-HARD | SDI |



UNCLASSIFIED

VG 88 U 0292-1
10 Mar 89

UNCLASSIFIED

# TWO GENERATIONS OF INFRARED IMAGING TECHNOLOGY

| IR MAVERICK MISSILE | |
|---|---|
| TOTAL WEIGHT | 675 LBS |
| VOLUME | 6.4 $FT^3$ |
| **ELECTRONICS UNIT** | |
| WEIGHT | 100 LBS |
| VOLUME | 1.64 $FT^3$ |
| THROUGHPUT | 4.0 MIPS |

| LEAP PROJECTILE | |
|---|---|
| TOTAL WEIGHT | 5.5 LBS |
| VOLUME | 0.14 $FT^3$ |
| **ELECTRONICS UNIT** | |
| WEIGHT | 0.62 LBS |
| VOLUME | 0.025 $FT^3$ |
| THROUGHPUT | 4.2 MIPS |

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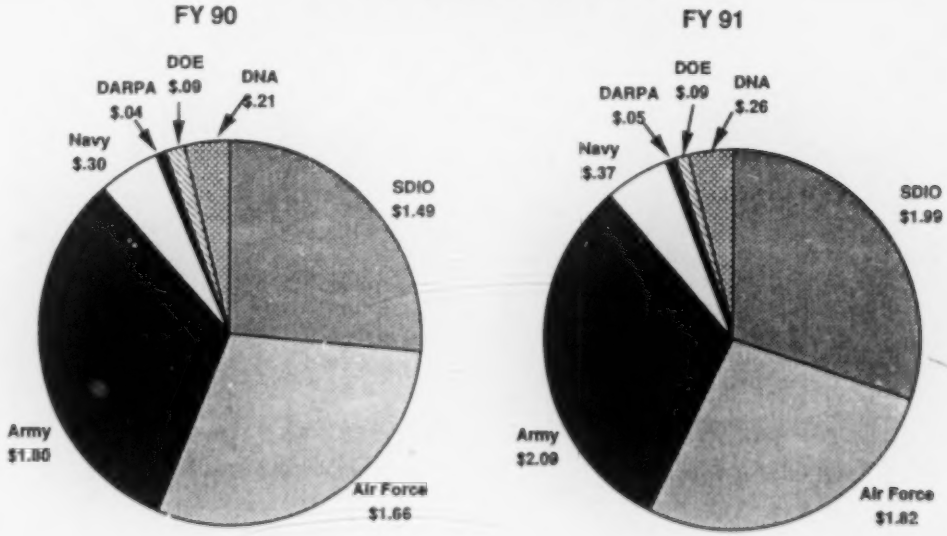
# FY 90-91 SDIO BUDGET

## Executing Agents ($ In Billions)




Total: 5.59B

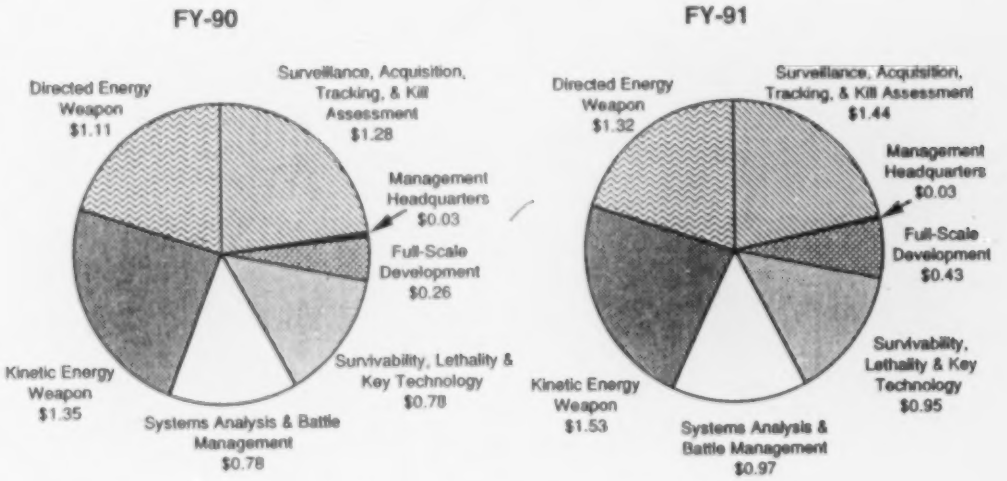
Total: 6.67B



jm-0580

# FY 90 - 91 SDIO BUDGET

## Program Elements ($ In Billions)


FY-90
Directed Energy Weapon $1.11
Surveillance, Acquisition, Tracking, & Kill Assessment $1.28
Management Headquarters $0.03
Full-Scale Development $0.26
Survivability, Lethality & Key Technology $0.78
Systems Analysis & Battle Management $0.78
Kinetic Energy Weapon $1.35
FY-91
Directed Energy Weapon $1.32
Surveillance, Acquisition, Tracking, & Kill Assessment $1.44
Management Headquarters $0.03
Full-Scale Development $0.43
Survivability, Lethality & Key Technology $0.95
Systems Analysis & Battle Management $0.97
Kinetic Energy Weapon $1.53

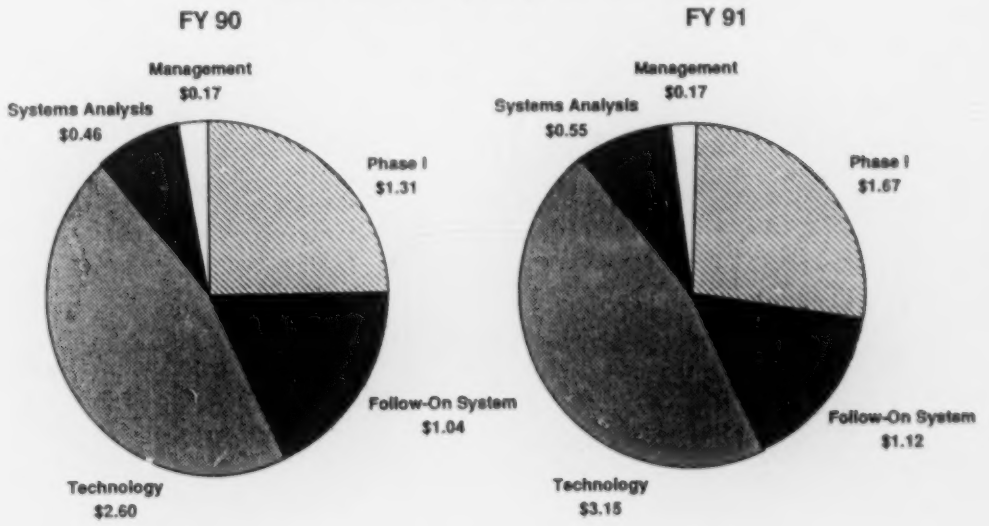


jm-0574

582

# FY 90-91 SDIO BUDGET

## Balanced Program ($ In Billions)






jm-0583

# SUMMARY

- Substantial Investment
- Significant Technology Advances Focused By System Analysis
- Current Budget Maintains Balanced Program

Mr. DELLUMS. Thank you very much, General Monahan, for your opening statement and the Chair would like to indicate to my colleagues that, as you are aware, normally the Chair has deferred to my colleagues to ask questions and reserved the Chair's time to ask questions at the end of the debate, but I would like to depart from this today. There are several important questions that I think need to be raised, and the Chair would like to raise them at the outset of these hearings in the hope that it will aid in clarification as the debate goes forward.

General Monahan, I realize that you are new to this job. President Bust does not at this moment have a Secretary of Defense. The strategic review is taking place and a budget reassessment is also taking place. Those limitations notwithstanding, I do choose to proceed with some questions in the hope that you will be able to answer the questions in whole or in part.

My first question goes to the conceptual issue of the Strategic Defense Initiative. Now, President Reagan had a vision of SDI as a laser-based population shield which, while politically appealing, apparently had little basis in the actual direction of the Strategic Defense Initiative Office and program spending. Most SDI funding, however, was actually directed at developing systems to protect missiles, not people, and using the so-called more mature existing technologies.

The initial pronouncements of President Bush have apparently down-played what I perceive to be this unrealistic population shield concept or what we call the Houston Astrodome mentality. Would you comment on the Bush administration's position concerning the direction and emphasis of SDI under the Bush administration and can we, at this point, dispense with the public relations approach and now debate the advisability of proceeding with an anti-ballistic missile defense system to protect our land-based deterrent forces so that the debate now will occur on whether there is efficacy in going forward with a system to protect our land-based missile system and get away from the discussion of population shield as a nonviable option?

General MONAHAN. Sir, as I mentioned earlier, and you also mentioned, we have the strategic review under way and I think the president's views will come out as that review is completed and as he has the opportunity to review it. Included in there among other things, will be what the pathway should be for SDI. So that is where that will come from.

Just a couple of other comments, however. Protecting people or protecting systems—a Space-Based Interceptor, a space-based system that I described, can protect anything you want it to protect in the entire world. I don't care what it is, you can protect it, people, places, wherever.

In the ground-based system, again, you have the choice. You can—depending upon how many Ground-Based Interceptors and radars and GSTSs we would deploy, we can protect the entire United States or the entire North American continent or wherever you want to put them. You are just wide open to choose as far as that is concerned. Don't make the mistake, however, of saying that all reentry vehicles or all missiles coming our way would be shot down. That is just not, I don't think, going to happen. But never-

theless, the system ought to be designed to be robust enough to shoot down a large number. .

You can design a system to protect whatever it is you choose, people, places, things, and you probably can be able to do all.

Mr. DELLUMS. So I can conclude from your comment that this debate will continue to go forward as a population shield and point defense simultaneously? You don't perceive whether some decision will be made to abandon this broader concept, because many people in Washington believe that what is envisioned at this point is focusing in on a point defense system, as opposed to this population shield that President Reagan sold to the American people as an Astrodome over the nation?

You just think that that decision is not going to be made at this point?

General MONAHAN. No. First of all, as I said, there are just so many options as to how one may go about it and how large an area we wish to protect. Depending upon how many interceptors, radars, et cetera the country should wish to have and you want a limited protection system, that sort of thing. Do you want to start off small and grow? There are a lot of different options there that could be pursued.

Mr. DELLUMS. My second question goes to the issue of the nuclear energy—use of it in this system. As you know, President Reagan has made much of the program being non-nuclear, and on a number of occasions to the American public, stated that this system was non-nuclear. Nevertheless, substantial SDI funds have gone to examining nuclear energy, both as a power supply and a source of weapons, including orbiting nuclear reactors and x-ray laser programs.

Would you comment, General, on the role of nuclear energy as both a potential power source and a weapon source within SDI? Can we now openly recognize that a significant part of the SDI program is, in fact, nuclear?

General MONAHAN. First of all, Mr. Chairman, the entire phase 1 system is non-nuclear. There is nothing nuclear in it at all. Where you will find nuclear type work is in looking at the advanced systems and the power supplies for the advanced systems in particular. I described a Space-Based Laser and it may need a nuclear power supply to be effective. We don't know yet, but because that is the case, we have technical work under way on nuclear power sources in space, just as the Soviets already have today. The Soviets do have nuclear power sources in space, so we do have work under way to see whether we can do that and if we need it for a Space-Based Laser, that is the major reason.

But the phase 1 system, today's system, the system I described in phase 1, which is quite robust, uses only kinetic kill-type vehicles, and does not require nuclear energy of any sort.

Mr. DELLUMS. General, you commented that beyond phase 1, that we—you used the term—"may" require a nuclear power source. Can you comment to the issue of the role of nuclear energy as the weapon source beyond phase 1?

General MONAHAN. There is a concept of something called an x-ray laser that would use a nuclear burst to generate the lasing power in space. That is a concept. Now, I am a little bit too new to

the program to know what kinds of funds we may have looking at that particular effort.

Maybe someone else knows, but I can tell you—I think I have learned in the past couple of months the major thrust of this program, and that one has never come up. Whatever is going on there—I don't know what it is—it has to be way over on the back burner.

Mr. DELLUMS. General, my third question goes to the debate regarding the ABM Treaty. As you recall, there has been a great deal of discussion in the Congress, both the House and the Senate, with respect to questions of violations of ABM Treaty. There is also a long lengthy discussion of the narrow interpretation versus the broad interpretation, which I frankly thought was a gross waste of time and an irrelevant discussion. I believe there is a much more basic and fundamental question regarding SDI and ABM that was not being touched in the narrow discussion of whether a broad or narrow treaty interpretation. It is a much more fundamental issue going to the logic of the ABM Treaty on the one hand and the logic of the Strategic Defense Initiative on the other. My question is designed to elicit a response from you in that regard.

The whole purpose of SDI, it seems to me, is to prevent ballistic missiles from reaching our territory. By definition, then, it is an anti-ballistic missile defense program. Therefore, SDI would violate both the terms and, in my opinion, the logic of the 1972 Anti-Ballistic Missile Treaty.

While debate exists concerning at what point SDI tests would technically violate the treaty, it would necessarily be violated in the next several years anyway. So the discussion of whether this test or that test violates the treaty, appears to be moot because down the road you are going to inevitably confront the treaty in very real terms.

More important, SDI would lead to the same offensive and defensive arms races that the ABM Treaty sought to avoid. The treaty was agreed to because the parties understood that without it, there would be a missile defense arms race and a corresponding offensive arms race to overwhelm the developing defenses system. SDI is, at a minimum, an ABM system; thus the logic of ABM applies directly to any SDI.

Therefore, is it not correct, General, that any deployment of SDI would, by definition, be inconsistent with and require an abrogation of the ABM Treaty?

General MONAHAN. I think the simple answer to that question is yes. As I mentioned in my briefing, the deployment of the Space-Based Interceptors or Ground-Based Interceptors in excess of 100 (100 are allowed, Ground-Based Interceptors are allowed by the treaty) is not in compliance with the treaty.

So you could not deploy the phase 1 system I described with the treaty as it stands today.

Mr. DELLUMS. Thank you for your candor, General. I will say to my colleagues that the significance of the General's answer is that the debate over narrow versus broad interpretation focuses on the issue of specific tests and whether they violate the treaty. But what the General is saying in very clear and unequivocal terms is that if you are going to proceed with SDI, you are going to have to abro-

gate the treaty, which means you have to come to grips with that issue because the logic of the two are in direct conflict with each other.

My next question is an offshoot of that. Even absent full deployment of any SDI, the testing of SDI components, which are by definition ABM components, would violate that portion of the ABM Treaty. How can we proceed with development and testing of SDI unless we are committed to the abrogation of the ABM Treaty?

Also, I am not sure if you can do this now, but I would appreciate it if you could comment on which SDI program experiments might possibly be construed as violating the ABM Treaty and the date you anticipate that those particular experiments or tests would be undertaken? You alluded to one. Is it possible for you to discuss what you perceive as a test that would be violative?

General MONAHAN. I can just make this statement right now, Mr. Chairman. All the tests that we have planned for fiscal year 1990 and fiscal year 1991 are treaty-compliant. We have already made that determination in the Treaty Compliance Review Group and it has given us the go-ahead. We have looked at some 25 or 30 tests and experiments right now that have been determined to be treaty-compliant.

We are not putting any funds in the next 2 years into anything, test-wise, that is not, indeed, treaty-compliant.

Beyond that, you need to take a look at the tests that might be coming up—even out beyond 1990 and 1991, on a one-by-one or case-by-case basis. The first issue is to determine whether or not they are treaty-compliant and then, second, ask ourselves the question, should we modify the test in some way, shape or form so that it can be treaty-compliant.

There is always the possibility of doing that. I have a treaty expert here with me today, but I don't know if it is useful to try to get into what specific tests may or may not be treaty-compliant out in the future. Until you really learn the real details of each test, you can't tell.

Like I say, we have already cleared some 25 or 30 tests.

Mr. DELLUMS. Thank you, General. I just have one additional question, but I would like to make one comment to my colleagues.

It is fascinating that a number of our colleagues who have said, "I oppose any abrogation of the ABM Treaty, but let's go forward"—it seems to me that that position is a contradictory position and you can't stand in that camp, it would seem to me, for long.

My last question General, concerns the Accidental Launch Protection System that some people are talking about. This is my final question and then I would yield to my colleagues and maybe come back later for some follow-on questions.

There has been some interest expressed in support of some type of accidental launch protection system program. Some version of ALPS or at least the PR is that some type of ALPS program would be "treaty-compliant." My understanding of the ABM Treaty is that territorial defense is explicitly prohibited by the ABM Treaty and that regardless of their being compliant with the ABM Treaty in terms of the number of launches, and numbers of launching sites. For example, to be meaningful any ALPS system would have

to provide territorial defense and therefore, by necessity, would have to violate the ABM Treaty.

Can you comment to that, please?

General MONAHAN. First of all, I do know that deploying an additional 100 interceptors is, indeed, permissible. Let me check one other thing.

May I let Lt. Col. George Ash respond?

Mr. DELLUMS. We agree on the 100 and the one site. The main thrust of my question is that if the treaty specifically prohibits territorial defense and if you are going to have a competent accidental launch program, don't you then, by necessity, have to violate the treaty?

Lieutenant Colonel ASH. Sir, I don't know that I can give you a categorical answer. The ABM Treaty does prohibit territorial defenses in Article 1, but the question of how much of an area that you defend has to do with what the mission of the ALPS, as you understand it and define it to be. As the General said, Article 3 allows you to deploy up to 100 interceptors to defend a particular area, based upon the sensors and the types of interceptors that you deploy.

But I don't think there is a position that an interceptor that has a very large footprint is noncompliant with the ABM Treaty. That decision just has not been made.

Mr. DELLUMS. I see.

Thank you very much.

The Chair would like to thank my colleagues for their indulgence. I think these are some basic questions that hopefully will clarify, at least in part, the debate as we go forward.

The Chair now recognizes the gentleman from Arizona, Mr. Kyl, for such time as he may consume, to be followed by Mr. Dickinson and Mr. Foglietta.

Mr. KYL. Thank you, Mr. Chairman.

General, let me ask you some questions first about the flight experiment, which was, of course, one of the key aspects of last year's authorization debate and one of the reasons that the president vetoed the authorization bill.

From what you testified to earlier in response to Mr. Dickinson's questions, because of the decisions early in our fiscal year debates, I gather that decisions were made at that point which set an irrevocable course of action which precluded you, then, from rehabilitating the program after it was reinstated? Is that correct?

General MONAHAN. That is more or less correct, whether or not irrevocable is, indeed——

Mr. KYL. Well, irrevocable to have the tests conducted in December of this year, in any event?

General MONAHAN. Right.

Mr. KYL. My understanding is that, notwithstanding the fact that by the time the bill was signed by the president, that nevertheless the flight tests are still on hold. The Air Force has recommended that they go forward, but SDIO has not yet signed off on that.

Do you know whether I am correct?

General MONAHAN. I could probably give you a much more definitive answer, Mr. Kyl, for the record, if you would allow that, but

we are planning for SBI tests downstream and I think it is the 1993–1994 timeframe. I believe that there just wasn't sufficient funding, as I understand it, left over finally this year.

Brigadier General Schnelzer was there during this and I was not. Perhaps he can give a more definitive answer.

Mr. KYL. We would appreciate that, thank you.

General SCHNELZER. If you go back to the cap of $85 million, that was a reduction of 75 percent. It went down to four times less than what we had. Of course, also, the 1988 appropriation came in the second quarter of the fiscal year. It was about a 30 percent reduction.

If you combine those two factors, it had a tremendous impact on the SBI program.

Mr. KYL. Excuse me, let's just be very clear on that. The debate that occurred approximately 1 year ago in the House of Representatives and the fact that the program, although it passed out of the full committee intact, was reduced by the time it finished floor action. That action alone was enough to stop the program, despite the fact that by the end of the year, and prior to the beginning of the fiscal year, it had been reinstated.

General SCHNELZER. That is correct, Congressman.

Mr. KYL. So that does demonstrate that our actions at this time of the year can have a very devastating impact on your planning.

General SCHNELZER. Tremendous. In fact, we took a 30 percent reduction in the total budget essentially given to us in January when the appropriation was made. If you combine a 30 percent reduction of that magnitude and combine restrictive language, what is forthcoming has a decided effect.

Mr. KYL. Now, to make the point, therefore, when the chairman talks about the necessary reductions from the Reagan budget and what we authorized, we are talking about actual tests, actual time lags and significant holes in the information that is required for further evaluation. But now to my question. What is the status of that now? You could put that back in the budget; you could conduct the experiments a year late, in December of 1990. Isn't that pretty critical for determination of where we go from here with SBI?

General SCHNELZER. Yes, sir. We tried to recover as best we could. As you know, with the passage of the bill, the first of this fiscal year, we endeavored to increase that amount of money from $85 million as much as we could and keep the integrity of the program intact. Our report to you in October, if I remember, was around 230 million, 240 million, if I remember correctly. That was our estimate of what we thought we could put back into the program. We have not quite reached that, but we have increased the amount of money for SBI by over 2.3 times over the $85 million cap. That is in the recovery.

Our agent in this case, the Air Force, had to essentially start over in some regards with a new profile what made sense and they are looking at test flights in the 1993–1994 timeframe.

Mr. KYL. How can you reach the information for the DAB Milestone 2 evaluation in the 1993–1994 framework if you don't conduct those tests in 1990?

General SCHNELZER. Sir, I think the perception that there is one significant test is misleading. There are a whole series of tests. I will give you an example.

This past year, we had a very key milestone take place at Edwards Air Force Base. We took the motor itself and conducted a test that showed that it, indeed, could provide the necessary motion as guided by its navigational unit. That took place this year.

This spring, we will have another key test. They will actually have a sensor in front looking out of this test chamber where you actually tie the whole device together from the point of the sensor looking at a target to controlling its motors. That is a key test.

There are a whole series of tests that evolve up to what we call, I guess, the very large flight test that would take place in the 1993–1994 timeframe. But those are very definitely incremental.

The star flight that we have coming up carries the kinds of sensors that would be appropriate to investigate how a Space-Based Interceptor sensor would work. That data is extremely important. So what we have done, as the chairman said, with our yearly reductions of 30 percent, we have kept intact what we think is a viable program, a balanced program, reflecting that vital engineering and technical data that allows us to make, I think, reasonable engineering decisions on what a Space-Based Interceptor is.

Mr. KYL. This particular flight experiment was represented to us as treaty-compliant, and my understanding is that it still would be. So the total time for slippage of this program, then, would be how many years?

General MONAHAN. I don't know that you could really measure it in terms of years. As General Schnelzer said, there are an awful lot of test events that are still going on, that are still scheduled to go on.

Out of the original request of $330 million, there is about $130 million lost, so that just called for a very substantial restructuring of the program. Whether or not anyone could accurately reconstruct to the point of saying, how much did you lose time-wise, I don't really know. We are now looking at a revision of the program again and concentrating more of our effort there rather than what went on.

Mr. KYL. I guess it is not as important to establish a specific time that has been lost here as to establish the principle that our playing around with the funding and decreasing it from the requested amount has had a significant impact in delaying the program.

Mr. DELLUMS. Would the gentleman from Arizona yield to the Chair for a moment?

Mr. KYL. Certainly.

Mr. DELLUMS. I appreciate the thrust of the gentleman's questions, but it seems to me they can be turned around.

What curve are they using to plan? If, over several years, the Congress has been consistent in making cuts in the range of 20–30 percent, then it is one thing for them to plan on the curve of that consistency. That, it seems to me, one could argue might produce an efficient viable program. But if they continue to plan on a higher curve consistently year in and year out, then it seems to me very difficult to rationally argue that you can have a viable pro-

gram planned out if that plan is always 30 percent above the reality, especially when it is being done several years in succession.

That was the thrust of the opening remarks of the Chair, so I would turn it around. While I think the thrust of the gentleman's questions put the burden of efficiency on the Congress, the Congress has spoken and it has done so consistently for about 6 years in the 20–30 percent range.

So should the other guys get the message that maybe we ought to plan on that curve, as opposed to this unrealistic "I am going to ask them in the $5 billion range and plan a program that they can't carry out because the Congress consistently doesn't give them those kinds of funds"? That is the question of the Chair.

Mr. KYL. Was that a question or a statement, Mr. Chairman. I don't know whether the witness——

Mr. DELLUMS. I think the General understands the thrust of my question. I mean, the question that I am asking is can you really say to the Congress that we are developing a viable plan when you consistently plan 20–30 percent higher than the Congress is willing to give you and you do that over several years?

Mr. MCCURDY. Would the gentleman yield?

Mr. KYL. I will as soon as I make a brief statement.

You see, the point, Mr. Chairman, of my comment was that the Congress came back, in its wisdom, following the president's veto of the authorization bill, and restored the funding. So we didn't cut that particular $230-some million, and yet, because of the actions and machinations that we went through, their program was totally thrown off stride there. That test was, in fact, canceled and now, instead of just having the test a year later, they have gone back to try to put it together in a little different way, as I have heard it described, to conduct some other kinds of tests and perhaps this test, then, might not be conducted for another 3 years.

Is that correct, General?

General MONAHAN. That is right.

Mr. KYL. Excuse me, Mr. McCurdy.

Mr. MCCURDY. I just wanted to ask what trend or path can you continue if Congress does under-fund, based on your request, and realizing that there is a consistent pattern in that under-funding? Some of us who have supported higher funding realize quite frankly it is probably not going to continue as long as the goals appear to be loftier than that which Congress is willing to support.

But if you were to go on an ALPS system or something else, do you have some alternative funding profiles that you are not telling us or do you continue, as Secretary Weinberger did for a few years, to always come in high expecting to get low? I mean, you are either being grossly under-funded or you are overly optimistic or you have something you are not telling us.

Where are we?

General MONAHAN. Let me try to take that, Mr. McCurdy.

First of all, when a budget comes over here, along with that is 5-year defense plan. What you see are at least the first 2 years of it, and by the way, someone in my position—the thing he would like to have would be 5 years' worth of funding or even more than that tied up.

In some countries they do it that way. They vote the funding for the project, for the entire project, over a period of several years and then they stick with it. That is the prevent the ups and downs and ups and downs and funding instability associated with the program.

So every time we send over a president's budget, we at least have programmed out what the program is for 5 years, and as you know, the president has submitted a budget this year that is to cover two years. That is at least a help, if not all five or six—what I would like to see—but at least it is the first two.

So every time it gets changed—by changed, I mean when the amount finally authorized and appropriated is, indeed different from that requested, then that, of course, upsets the plan, the 5-year plan, and you have to go back and redo it and regroup. That occurs with the SDI program with some regularity. It occurs in other programs once in a while also.

So if I had my druthers, I would like to see a much longer period of time that I could count on in pursuit of a program.

Now, the next point, in the strategic review that is ongoing—obviously, in the strategic review, we are not looking at just the short-term; we are looking at the longer term, and we are looking at at least a 5-year period, and indeed, even making some projections out beyond that.

So what will emerge from the strategic review will be a plan for all of our strategic programs, as well as the Strategic Defense Initiative, and that will be the next plan. Budgets will be based on that; budgets will be put together on that. To the extent those budgets aren't supported, then, obviously, that will put instability into the plan or make us go back and replan.

Mr. McCURDY. If I can just clarify that a little more—I wasn't trying to pose it as an impossible question, but——

Mr. DELLUMS. Does the gentleman from Arizona continue to yield?

Mr. KYL. Yes, I do.

Mr. McCURDY. Just on one point, and I appreciate the gentleman yielding.

In May of 1988, the Defense Science Board made a recommendation that you go forward with the surveillance system, in addition to a separate track, but I think they realized that, one, the funding and the planning curve were not going together. So they said, let's separate and go ahead and do the surveillance track and have that as a separate course.

Is that not a higher realization of the dynamics of whether it is Congress under-funding or, whatever the realities are—but they realized that that is the first thing that you ought to go ahead and do and that—to continue to have a phase 1 as a total concept is unrealistic to date?

General MONAHAN. I don't know if that is really so, Mr. McCurdy.

First of all, in phase 1, as I showed, the things that come first are the sensors. BSTS is the first to enter full-scale development, followed by the other items there, and what comes last, as I recall, are the Space-Based Interceptors.

So phase 1 is more or less designed to do just that, but I mentioned also that the phase 1 response to a Joint Chiefs of Staff requirement—the Joint Chiefs of Staff requirement went further than just saying we need to see things; it also says we need to destroy ballistic missiles that would be incoming and so phase 1, then, is designed to respond to that requirement. Therefore, phase 1 needs to have the interceptors associated with them, as well as the sensors.

I think that the phase 1, as approved by the Defense Acquisition Board, didn't go quite so far in doing sensors first and then interceptors. It really kept them a little bit closer together than that original proposal, but nevertheless, the sensors still do come earlier.

Mr. DELLUMS. Does the gentleman yield back his time at this point?

Mr. KYL. Yes, Mr. Chairman. I had intended to yield to my colleague, Mr. Dickinson.

Mr. DELLUMS. OK. Thank you.

The Chair would like to indicate to my colleague that, time permitting, we will get back to the gentleman. I know he has a number of additional questions.

The Chair would now recognize Mr. Dickinson for such time as he may consume.

Mr. DICKINSON. Thank you, Mr. Chairman.

Not to belabor the point, but to paraphrase what I understood your agreement with the questions posed by my colleague from Arizona, we protected, in the final conference, the money that has been spent in the bill and which some of us knew was wreaking havoc with the total program and in conference, after the veto and reporting of the new bill—we unfenced it and directed that none of these major programs—there were four, as I recall—take a disproportionate hit or cut.

Now, you are saying that there was a disproportionate hit on the program, but that this has been caused by the turbulence in the program or reduction of the program before so that you had had to cancel and then lay off people and you couldn't regenerate it.

Am I saying substantially what I understood the case to be?

General MONAHAN. That is substantially correct, yes, sir.

Mr. DICKINSON. So the mischief was done before the veto was enacted and——

General MONAHAN. Absolutely.

Mr. DICKINSON. OK. So at least we tried, some of us did anyway.

Let me get back to a very telling point, that my chairman raised with you, dealing with the ABM Treaty and the SALT I, SALT II. I think you agree, and I agree, that at some point, there has to be a resolution of do we go forward with the SALT II or SALT III; are we, in fact, headed on a collision course where it would be violated?

You have said yes, at some point, if we continue everything that we have on the drawing board, that we will probably abrogate the treaty, even though we don't have a treaty. But on the opposite coin, we know, in fact, that the Soviets have a substantial effort ongoing also.

Is this correct or not?

General MONAHAN. The Soviets have a deployed ABM system.

Mr. DICKINSON. Well, aside from the system, within—that is the 100 Gulash around Moscow. But we also know they have a rather robust SDI-type program ongoing also, do we not?

General MONAHAN. We know they have some research efforts under way, yes.

Mr. DICKINSON. That is a pretty weak answer from what I understand.

General MONAHAN. Beyond that, Mr. Dickinson, I think I do start to get classified.

Mr. DICKINSON. Maybe we ought to flush the room and get the facts. The fact is, as I understand it, that the Soviets and the United States are probably paralleling each other's efforts pretty substantially. Maybe we are going in some directions differently, but at some point, they are going to be faced with the same choice that we are. They have a robust R&D effort dealing with the types of programs that we are dealing with and if we sit on our hands because we say, "Well, we can't do anything because we might run afoul of the treaty," then we will, in fact, be in the soup, so to speak, because the Soviets are progressing apace with us, as far as we know. We have reason to believe that is true and that—these are my words, not yours, and you can confirm or deny that in a classified session—but the point being, if we don't go up to that point and then have a resolution on whether or not there will be a new SALT, then the Soviets will have no reason to enter into a new SALT. They will have that capability. We will not have developed anything to entice them to come and negotiate a new treaty and so we will have dealt ourselves out of the game completely.

Would you agree with that?

General MONAHAN. We can do an awful lot technically under the treaty as it is today. If I gave an impression that I can't do this unless you change the treaty, that is entirely wrong. I mean, we can and should do an awful lot of work here.

Mr. DICKINSON. I am not making myself clear. The chairman said, and I agree with him, that if we proceed along the lines that have been laid out for SDI, and go forward with the plans, at some point, we will run up against the treaty and have to make a decision to abrogate it or not; is that right?

General MONAHAN. Yes. Yes, sir.

Mr. DICKINSON. OK. So we are not planning to abrogate the treaty at this point until at least we know that the Soviets are. If we don't go forward with our research and development efforts up to that point, then there is no reason to ever think that the Soviets would enter into another treaty because there is no reason to, where they have the capability and we don't.

Would you agree with that?

General MONAHAN. I would say that is indeed possible. I am not an expert on arms control, Mr. Dickinson, but it strikes me that what you say is——

Mr. DICKINSON. I am really asking you about the tenor and the tone and the direction of our research and development efforts. We know where they are going and we know at some point we have to either renegotiate with the Soviets or else we will both abrogate and go forward.

Let me ask you a little more mundane question. We know that in order for a Ground-Based Laser to be effective that you have to deploy satellites and mirrors to deflect and reflect the laser beam itself. The biggest problem—or one of the biggest problems is going through the atmosphere. Am I right so far?

General MONAHAN. Yes, indeed.

Mr. DICKINSON. OK. Does it make sense, is it practical and are we experimenting with the concept of putting such a power system on an aircraft that could take it up through most of the atmosphere? Is that reasonable? Or have we discounted that?

General MONAHAN. We used to have an airborne laser laboratory and we finally grounded it. Maybe those are the reasons why. You would have to get an awful lot of power onboard that airplane and the big problem with doing that is power on airplanes.

Mr. DICKINSON. I know that is a problem, but it also reduces the requirement the higher you get, so the question is, do we have an ongoing experiment? Have we tried that and discarded it as not practical?

General MONAHAN. Dr. Mike Griffin, our technology expert——

Mr. DICKINSON. OK.

Dr. GRIFFIN. Just to comment very briefly, the main problem in putting a laser such as you describe on an airplane in place of the ground-based free-electron laser or other laser concept would be the power source required on the airplane. Now, we are looking at—you didn't ask this question, but we are looking at space-based applications of that laser. That is in a follow-on timeframe to the current GB FEL work that is ongoing in the technology directorate.

But for airplane use, we don't see the availability of a compact power source at this time.

Mr. DICKINSON. Even though the higher you get, the less energy it would require—you still wouldn't have enough?

Dr. GRIFFIN. That eases the atmospheric compensation problem, but it does not alter the requirement for laser brightness to a significant degree. That is a power issue.

Mr. DICKINSON. So, for that reason, we would go to Space-Based Laser, rather than try to develop some aircraft that would do that?

Dr. GRIFFIN. That would be the thinking at this time. If there is a breakthrough in compact energy storage or something of that nature, then it would be time to reevaluate.

Mr. DICKINSON. In closing, Mr. Chairman, and I don't want to monopolize all the time, it is my recollection that the ABM Treaty that was agreed to was put in place based on the logic that we would put this SALT treaty in place and then that we would have a reduction in offensive weapons. We observe that for 7 years, and then we negotiate a SALT II, which was not ratified. Now since then, we have not seen the reduction in weapons that the first and second treaty envisioned.

So it was not ratified and so we can't always be held to that. When the first treaty was put in place, we didn't have a concept of SDI, and so all this has been a result of developments since—technologies have been recently developed. They were never envisioned when the treaty was put in place.

So at some point, we have to make another determination: Do we want a new treaty with the Soviets and then what will that treaty

encompass? Will the Soviets then come to the table based on the fact that they are assured that we have a capability also or will they say, "Who are you kidding; you don't have any effort going worth mentioning and we have a robust system and we don't need a treaty?"

Thank you, I yield back.

Mr. DELLUMS. The gentleman yields back his time.

Mr. Foglietta is recognized for such time as he may consume.

Mr. FOGLIETTA. I thank you, Mr. Chairman.

General Monahan, in 1983, I remember attending a breakfast at which the speaker was Dr. Edward Teller, and he conceptualized what he believed could be the development of the SDI program.

Today, except for the reduction of sophistication of some of those concepts into sketches, I see the reduction in size, the expansion and efficiency of some component parts, and the expenditure of some $14.7 billion, and I still don't see much of a development from the concepts expressed by Dr. Teller 6 years ago.

Is that because this is an unclassified, open hearing and would it be different if it was a closed hearing?

General MONAHAN. I don't believe that that would make a substantial difference, whether or not we were closed, in that particular point. I think what you are finding is that the program is getting now to the stage where you are going to see an awful lot more in the way of hardware that has been developed and is now in an experimental stage.

Somewhere in here I think I have a list of all the tests that we plan for the next 2 years and it is, indeed, this long, and there will be substantial. For example, we will have a beam experiment aboard rocket here just next month and there are quite a few. Here is an entire list of them right here and I could furnish these to you.

Also, in the *Report to Congress* which we submitted—the classified version in January and then the unclassified version just today—you will find these laid out. I think that would give you a better indication of just where we are.

Mr. FOGLIETTA. To what extent have we advanced in the development of these technologies that we heard about 6 years ago?

General MONAHAN. First of all, we have advanced to the extent that we are able to finally coalesce them down into the various elements that I showed today, and it takes advancing technology to get them down to figure out, yes, indeed, this is the way now that it ought to be packaged, and know that you have a very good chance that they will work.

Then, having done that, now we have taken them into the next stage of development, which is just short of full-stage development. We call it the demonstration and validation phase. So all of those elements in the phase 1 system are in that phase today, except for the Ground-Based Radar, which is just about to enter denial.

That says that you have advanced the technology far enough so now you are at the point of being able to test a certain amount of hardware and now you can start narrowing down your specifications so that in a couple of years, when you get to the full-scale development phase, you are up and you are ready to go.

The spending has been—by comparison, has been like this at the present time and when you get into full-scale development, then it would rise further.

Mr. FOGLIETTA. I also see a book that was distributed here promoting the SDI technology transfer to the United States public and private sectors. Suppose we had diverted the $14.7 billion over the last 5 or 6 years to commercial research. Do you think that would have been advisable?

General MONAHAN. The president established the SDI program. First of all, what he did was, in establishing the SDI program, we brought together, many technology efforts that were under way out there, but they were fragmented, and they weren't integrated properly. So an awful lot of what you see here and what SDI has done for the past 5 years is effort that was already on the books and people had already planned to do.

I think you are into some very key technology areas here, as Mr. Dickinson mentioned. The Soviets aren't stopping out there. There is no question about that, although I can't get into details with you, but they are looking at it very, very robustly, at a lot of areas of technology. So, if we don't, we do so at some great peril.

I think that the money has been, indeed, very, very well spent, even if you went no further in the program. I don't advocate that, but that is the case.

Mr. FOGLIETTA. I thank you, General.

I yield back the balance of my time.

Mr. DELLUMS. The gentleman yields back his time.

Mr. McCurdy is now recognized for such time as he may consume.

Mr. MCCURDY. Thank you, Mr. Chairman.

General, I am curious, since we have been addressing this over the past 5 years, how much change there has been in SDIO. How many personnel are within the organization at this point?

General MONAHAN. In the SDI organization, in the Pentagon, about 260 people.

Mr. MCCURDY. Two hundred and sixty?

General MONAHAN. Two hundred and sixty, yes, sir.

Mr. MCCURDY. What percentage of turnover would they have had in that group? Have you had high turnover of scientists? Have you have had a fairly constant group there?

General MONAHAN. I haven't been there long enough to note, to tell you truth.

Mr. MCCURDY. Do any of your briefcase carriers back there have any?

General MONAHAN. They might, but I don't think it's been inordinate one way or the other. I will tell you this, if you can find any better scientists and engineers somewhere, in Government or in industry, be my guest. But they really are an excellent crew.

Mr. MCCURDY. I am curious whether or not you had difficulty attracting personnel, and if so, is it an issue of how much you can pay, the degree of challenge, the science, the love of the challenge itself? Are you having a hard time recruiting people or do they come, stay a year and go off to some private company at three times the salary? What is the——

General MONAHAN. I don't think the program has enough experience just yet to know whether or not enough people would turn over and move on out to jobs in industry. Because of the nature of this program, I think we are a magnet for very bright people, and I think that is probably what sets SDI apart from other programs. I think in other areas within the Government, we clearly do have a lot of difficulty attracting the kind of scientific and engineering people that we need to have.

Mr. MCCURDY. DARPA, for instance, testified a few weeks ago that they actually have a policy of having turnovers. Again, I am just curious about the philosophy within SDIO as far as the type of people you want to attract, how long do you want to keep them and are you having difficulty in keeping them? Would you furnish that for the record?

General MONAHAN. I would be very happy to do so.

[The following questions were received to be answered for the record:]

*Question.* DARPA, for instance, testified a few weeks ago that they actually have a policy of having turnovers. Again, I am curious about the philosophy within SDIO as far as the type of people you want to attract, how long do you want to keep them and are you having difficulty, and if you could, if you a personnel manager or some one over there, would you furnish that to us.

Answer. SDIO has no formal policy established on having turnovers. Our turnover rate, I feel is low, and is generally caused by the routine turnover of the military officers and enlisted personnel currently assigned to SDIO. Our civilian work force, in my opinion, is very stable. Our secretarial work force is our largest area of turnovers and is typical of the clerical work force in the Federal Government today.

We seek highly specialized individuals, be it military or civilian personnel. This is primarily a direct result of the mission of the SDIO. Due to the extensive research and development required to have an Strategic Defense, we must attract individuals whose background is extensively involved with the various technologies that we require, i.e. DEW.

The SDIO has a Chief of Staff whose responsibility includes the manpower, personnel issue. In addition, we have a Resource Management Directorate which includes a Human Resources Division. Our personnel office serves as liaison personnel office, not an operating one, and we receive support in these areas from Washington Headquarters Services.

General MONAHAN. I will tell you this, I want to attract the very best people we can. I think we have been fortunate because the nature of the program is a real magnet and I would like to keep them just as long as we possibly can. We might move them around within the organization——

Mr. MCCURDY. Has SDIO taken the approach, say, of DARPA, as opposed to strictly program managing or programs such as the F–16, where you have actual large numbers of people? Are you more just managers going out and saying, "Well, here's the areas we want to go contract in. We let contract and we supervise those contracts." Is there a difference in philosophy——

General MONAHAN. Within our Organization in the Pentagon, there is a mix of management-type people and scientific and engineering people. We are just the tip of the iceberg. Right now, we estimate 30–33,000 people in this country are working on the SDI program.

In fact, I have some additional data about that. I would be happy to provide it to you, but we are just the start. An awful lot of the work we do is performed by the Army and the Air Force, some by the Navy, DARPA, Department of Energy, et cetera. We get just

excellent work from the national laboratories under the Department of Energy.

Then we do a fair amount of it ourselves. Obviously, the responsibility to integrate all of those various elements that I briefed you on—that can rest nowhere other than within the SDI organization itself, so because of that, we need managers, scientists and engineers.

Mr. MCCURDY. Let's focus on cost for just a minute. I was fascinated by the chart in your briefing that shows the curve coming down on the cost. I only wish we had other program managers who came before us on this committee with similar experience. Most every program we have had thus far has actually had a learning curve going the other direction. Maybe we ought to take these 260 people and put them elsewhere in the department. I don't care if it is a system that I strongly supported, such as the C–17 transport aircraft, which seems to have some cost growth, whether it is an ATF or an ATA or just even a simple missile systems.

Now on page 27, the cost you indicate from 1988, from the DAB review there, from June 1988 to September 1988—you are forecasting, because of technology developments, a reduction of some $40 billion and your cost goal is the further reduction of almost another $15 to $20 billion. How are you able to accomplish this?

General MONAHAN. OK. Let me take the first part of how it came down here to the $69 billion from what it had been before. Technology development was part of it; another part of it was descoping a good portion of the program, not just many of the interceptors. Recall that phase 1 is built to fulfill a JCS requirement. The requirement is classified, but nevertheless, it is designed to do that. They found they didn't need quite as much in the way of fielded hardware to fulfill that requirement and that is one of the major reasons why it was reduced down to $69 billion.

There also was—because the technology is moving kind of fast—a determination that certain of the hardware could really do more than originally planned. So that is how it got down there to the $69 billion.

Mr. MCCURDY. So it is not technology development, per se, it is a change in the requirements.

General MONAHAN. It is both.

Mr. MCCURDY. Tell me a little more about the technology development. You told me about the change in requirements. What significant breakthrough has there been that allows that cost reduction?

General MONAHAN. I don't know that there was a real significant breakthrough. Let me just check.

OK. Certain functions that were duplicated on certain elements of the program, they removed the duplication. For example, certain things that SBI was doing, the SSTS was already doing. They took some of that function away from the SBI and brought that down to SSTS. I don't think you can call that technology development, so I don't think I answered your question yet. We need to take that for the record.

Mr. MCCURDY. I would be interested to see that.

The following is Lt. Gen. Monahan's testimony to the Subcommittee on Legislation and National Security, Committee on Government Operations. Attached to the testimony is an SDIO information paper that provides detailed discussion on the reasons for the change in acquisition cost from June 1988 ($115B-88) to October 1988 ($69B-88).

98-110 O - 89 - 20

PREPARED STATEMENT OF LT. GEN. GEORGE L. MONAHAN

Mr. Chairman, your letter of invitation asked me to testify before the Subcommittee on Legislation and National Security, on the subject of cost estimating methodologies and the basis for the cost estimates for the potential Phase One Strategic Defense System (SDS).

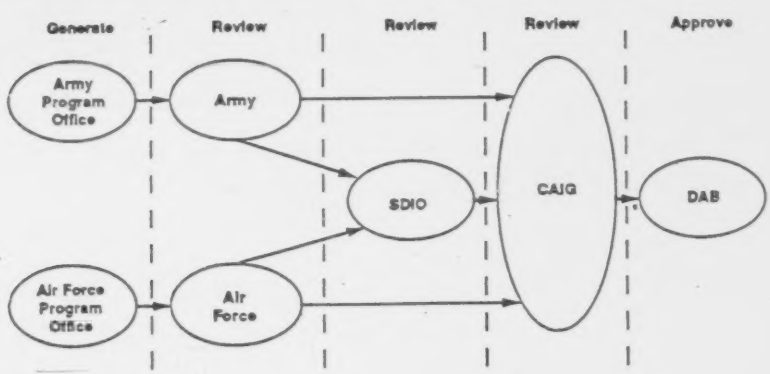
Cost reduction has long been recognized as an important component of the SDI program, and cost-reduction efforts have been emphasized in tandem with technology research. By anticipating potential SDS costs, and by implementing technology development strategies that focus on reducing costs, we believe we are focusing directly on one of the key issues of SDI, affordability. As Lieutenant General Abrahamson testified last October to the joint committees on Armed Services, the current estimate of the total cost to demonstrate, validate, develop, produce and deploy the first phase of an SDS is $69 billion in constant FY 1988 dollars (B-88). This figure is a substantial cost reduction from the $115 B-88 estimate of June 1988, and we expect even further reductions as architecture refinements and other improvements are made. The reduction to $69 B-88 was achieved largely through eliminating unnecessary redundancy from the SDS architecture and operational concept, increasing space-based interceptor performance, and reallocating interceptors from space to ground.

I think it is important to note that the majority of our cost estimates are the product of current Army and Air Force cost estimating methods and processes used for <u>all</u> weapon systems.

These Service cost analyses are based on the actual cost histories of existing systems and projections of the impacts of new technologies and processes. Chart 1 illustrates the process by which the $69 B-88 cost estimate was reached. A final review is conducted by the Cost Analysis Improvement Group (CAIG), before presentation to the Defense Acquisition Board.

Chart 1

THE SDS COSTING PROCESS




I have attached to my statement an unclassified information paper detailing how SDIO arrived at the $69 B-88 cost estimate. I think you will agree with our conclusion that the cost reduction achieved last year was a result of finding a better way to do the job, not simply "improving" the cost analysis procedures.

SDIO will continue to sponsor research that will aim at reducing both the costs of systems due to performance requirements and the costs of systems due to administrative and regulatory requirements, and continue to emphasize the importance of how much a system "could cost." Our goals are a properly balanced architecture that allocates functions in the most economical way, and an industry that efficiently adds value to its products using the most appropriate technology and capital base. SDIO will continue to set challenging cost objectives, and will continue intensive efforts at cost reduction.

While we have estimated the cost of Phase I to be $69 B-88, we are reviewing alternative architectures and technologies that could result in the cost estimate being substantially reduced from $69 B-88. Phase I has just entered the Demonstration and Validation phase; it is at a very early stage in the acquisition process and cost estimates can change. We anticipate achieving cost goals and bringing the total cost of Phase I below $69 B-88.

I am prepared to address your questions.

- Information Paper -

# STRATEGIC DEFENSE SYSTEM COST REDUCTION June 1988 to October 1988

March 21, 1989

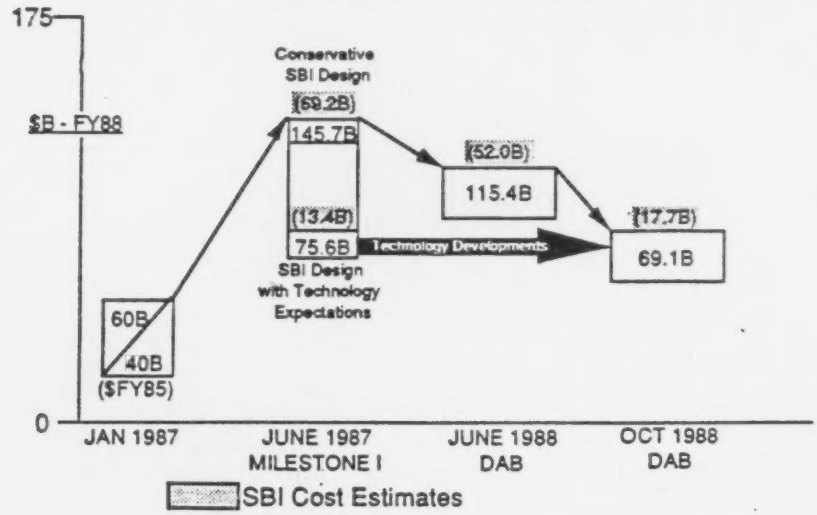
*Phase I of the Strategic Defense System is currently in the Demonstration/Validation phase of system acquisition. As such, it is undergoing research, development and testing aimed at developing an optimal system to enter Full Scale Development. SDS Phase I is a "system of systems" in that its major elements (see following) are systems in their own right. The overall costs of SDS Phase I depends on the functions assigned to each of these elements, the degree to which these functions must be assigned to more than one element to bolster confidence, and the projected availability of key technologies. In the process of developing SDS Phase I, significant improvements have been realized in the cost to perform its mission. This paper discusses those improvements.*

## I. INTRODUCTION

The latest official DoD (SDIO, Army and Air Force) estimates for the acquisition of the initial phase (Phase I) of the Strategic Defense System (SDS) saw significant refinements and reductions between June and October 1988, dropping from $115 billion to $69 billion in Fiscal 1988 dollars. This resulted from reallocating functions, earlier realization of technology expectations, removing excess performance and continued refinement of the system definition. These reductions were accomplished while maintaining the ability of the system to satisfy its mission requirements and without major changes to cost estimating methods.

The evolution of acquisition cost estimates from the initial cost projections in January 1987 through the Defense Acquisition Board (DAB) Milestone I review and subsequent update reviews is depicted in Figure I-1. The original January 1987 estimates were based on an architecture that was designed for production of a strategic defense system as soon as possible. At Milestone I, as the Joint Chiefs of Staff requirements were established, the costs reflected a more robust architecture to meet those requirements. Note that uncertainties in architecture design requirements at that time resulted in a range of costs corresponding to a range of technical options.

Figure I-1. SDS ACQUISITION COST EVOLUTION



The October 1988 estimate reflected a more mature design and updated technology projections than were used for the June 1988 estimate. The October estimate also reflects more emphasis on ground-based weapons for the initial deployment. The cost of the Space-Based Interceptor (SBI) element is highlighted in this chart because of the dramatic change in its acquisition estimate. From June to October, Space-Based Interceptor (SBI) weapons constellation size decreased by 51% while ground-based Exoatmospheric Reentry Vehicle Interceptor Subsystem (ERIS) weapons increased by 70%. These quantity changes incorporate improved SBI performance and survivability measures, and reduce architecture performance that was previously above the Joint Chiefs of Staff requirements for the Strategic Defense System Phase I. Nevertheless, these tradeoffs were made not only on the basis of reducing costs. The robustness of the mix of SBI and ERIS elements to countermeasure alternatives was an important factor in the October 1988 estimate.

The remaining discussion will present: an overview of cost analysis and estimation techniques used, reasons for the changes in cost, details of the cost reductions, a discussion of system performance, and conclude with SDIO's plans for continuing cost reduction and attainment of cost goals.

## II. COST ANALYSIS

In order to put the cost reduction effort in perspective, an understanding of some basics of cost analysis is required. The 1988 service cost estimates are the product of current Army and Air Force cost estimating methods and processes used for all weapon systems. These Service cost analysis systems are based on the actual cost histories of existing systems and projections of the impacts of new technologies and processes. Further, assessments have been made by all levels of the Service command structures in order to determine whether the work described can be performed within the estimate. The cost reduction observed between June and October of last year was a result of finding a better way to do the job, not by simply "improving" the cost analysis procedures.

Cost estimates are developed in dollars for a given "base year", normally the same fiscal year in which the estimates are generated, representing what a system would cost "today." In actuality, the costs are distributed throughout the life of the system acquisition. Projected inflation rates by year can be applied to the constant year estimates to obtain an escalated estimate, but this estimate would over emphasize later costs (e.g., in production) and not be comparable to the costs of systems acquired in different timeframes.

Cost estimate development uses a combination of three cost estimating methodologies: parametric, analogy, and engineering build-up. Parametric methodology involves the use of Cost Estimating Relationships (CERs) which relate a selected design or performance parameter (e.g., weight, power) and an item's cost. Analogy estimating derives a cost from data on an existing system based on engineering judgement of the effects of complexity, technical, or physical differences. Engineering build-up is applied to items where estimates are attainable at the lowest functional level of detail (e.g., direct labor, tooling, materials).

Design, performance or other technical characteristics that best describe a system are selected to estimate costs and are termed "cost drivers". History and logic have shown that the cost of a system varies in relation to the value of these characteristics. There are many cost drivers, but those that cause the majority of near-term changes in system cost fall into three primary categories: size, complexity and technology.

Size is the most dependable of the three; when other aspects are the same (parts density, manufacturing complexity, product technology, etc.), then the size of an item will directly relate to its cost: bigger houses cost more; 10 pounds of hay costs more than 5 pounds. However, the relationship between cost and size is not necessarily linear. "Economies of scale" can occur which result in the cost-per-unit-size of larger items to be less than that for smaller (the "large economy size" phenomena). Size increases often result in proportionally lower cost increases.

The impact of complexity is illustrated by the comparison of satellite mechanical structure to satellite communication equipment. Satellite structure involves few pieces but is the result of a complex design and production process because it must be as light as possible and adapt to wide ranges of temperature. The complexity of the communication equipment far exceeds that of the structures. The communication equipment material must meet the same weight and temperature requirements as the structure, and be built so that its many parts and connections operate for long periods of time. Products are split into similar complexity level groups for analysis. Therefore, estimating relationships developed for structures yield lower costs than those for communication equipment for like sizes.

The goal of technology development is often to reduce the cost of a function or product. The control of technology and the anticipation of the impact of new technology on system costs are major problems facing our acquisition system today. Available, simplifying technologies bring costs down, while rare and enabling technologies may drive costs up. This requires that the mix of technology in a product be carefully tracked when developing a cost estimate. The SBI Focal Plane Array (FPA) is an example of a technology that is expected to make the transition from expensive to cheap, and the consequent possibility of replacing a scanning array with a staring array is one of the reasons that the estimated costs of SBI could be reduced so dramatically.

In the past, costs of individual units have been observed to decrease in a somewhat predictable manner as the quantity increased. These reductions are attributable to job familiarization by workers performing repetitious tasks, general improvement in tool design and utilization, production control improvements, reduced scrap, improved materials flow, and other factors. "Learning curves" are non-linear equations that are applied to almost all production cost estimates, especially where the units involved justified planning and tooling activities over those used to produce a development, or prototype, unit. The "learning" concept's importance to this discussion is enhanced by the fact that several of the cost increases and decreases of the Phase I elements were directly related to quantity increases and decreases. The non-linearity of learning; however, precludes a one-to-one comparison of the cost change to the quantity change (i.e., a 50% reduction in quantity equates to a less than 50% reduction in cost).

The above discussion provides a brief summary of the analytical issues which are addressed in the cost analysis of modern defense systems. It does not provide a comprehensive review of the topic, but should be of assistance in understanding the cost changes discussed in the following section.

## III. COST REDUCTIONS

Overall the acquisition costs for Phase I SDS between June 1988 and October 1988 declined 40% (Table III-1). Only three of the nine elements had modest cost estimate increases (ERIS, GBR, Launch), while four had major decreases. Of these elements, the one with the most dramatic reduction was the SBI going from $52 billion in June to $17.7 billion in October, a decrease of 66%. It is important to note that a performance reserve is allocated to allow for additional capability expansions if required to meet a changing threat, and that the management reserve ("Cost Reserves") imbedded in the estimate exceeds 10% for both Development and Production phases. This reserve is a key part of stablizing costs in a changing technology and threat environment.

TABLE III-1. ACQUISITION COST REDUCTIONS (FY88$ IN BILLIONS)

| Element | Jun DAB | Service Briefs (Oct 88) | $ Reduction | % Reduction |
|---|---|---|---|---|
| BSTS - Boost Surveillance and Tracking System | 9.0 | 8.0 | (1.0) | (11%) |
| SSTS - Space-Based Surveillance and Tracking System | 12.6 | 9.2 | (3.4) | (27%) |
| GSTS - Ground-Based Survillance and Tracking Systems | 3.6 | 3.3 | (.3) | (8%) |
| SBI - Space-Based Interceptor | 52.0 | 17.7 | (34.3) | (66%) |
| ERIS - Exoatmospheric Reentry Vehicle Interceptor System | 4.8 | 5.8 | +1.0 | +21% |
| BM/C3 - Battle Management/Command, Control and Communication System | 14.6 | 7.3* | (7.3) | (50%) |
| GBR - Ground Based Radar | 2.7 | 3.1 | +.4 | +15% |
| SE & I - System Engineering and Integration | 7.8 | 5.0* | (2.8) | (36%) |
| LAUNCH | 8.3 | 8.6* | +.3 | +4% |
| Cost Reserves (Imbedded) | — | [7.6] { DVMT = 18.4% PRDN = 14.4% | | |
| Performance Reserves | | 1.1 | +1.1 | — |
| TOTAL | 115.4 | $69.1 | (46.3) | (40%) |

* SDIO ESTIMATES [] NON ADD

A major factor behind the cost reductions was the evolutionary elimination of redundancy from the SDS architecture and operational concept. An extensive architectural analysis highlighted areas in which overlaps in functions existed unnecessarily between individual elements. Although pre-planned redundancy is a legitimate instrument for reducing risk or increasing survivability, the existence of unplanned redundancy can

increase costs without helping risk or survivability. The other factors behind the cost reductions were technological advances and architectural improvements. Minor changes in cost estimating methodologies were made only in the rare cases where new reference data was available. Table III-2 lists the changes in primary technical cost drivers from June to October as a percentage of the June baseline. Changes in cost relate to the changes in these cost drivers. This can be seen in the following discussion of Phase I elements.

The most substantial portion of the overall SDS cost reduction was due to the 66% reduction in SBI, which was achieved through a combination of several factors:

Communications/Processing: The amount of SBI Communications/Processing equipment has been decreasing. Initially, Communications/Processing in SBI was reduced as technology development allowed more specific selection of components (June 1988 case), and then the BM/C3 function was removed since it was redundant to that on the SSTS. This significant reduction in weight generates a significant reduction in the cost of the current SBI system.

Infrared Sensor: This equipment provided the fire control capability for initial high-cost cases. The June 1988 version of the SBI carrier vehicle had sensor, laser gimbal and structure hardware to perform this function. Further, this equipment increased power, thermal control, structure, reaction control and propulsion requirements of the basic carrier vehicle. By removing the fire control function from the carrier vehicle, the cost of the equipment and the cost of accommodating it was saved. The reduced complexity of the satellite greatly reduces development risk as well.

Quantities: The reduction in quantity of interceptors and carrier vehicles in the current SBI concept significantly reduces the recurring production cost of the SBI element. For example, by reducing the total production quantity by 53%, the recurring production cost for the constellation can be reduced by 49% even if no other changes take place due to simple learning effects.

Carrier Vehicle Weight: This parameter refers to the weight of the carrier vehicle without interceptors, communications, processing or other payloads. Although the weight of the June 1988 and October 1988 designs are nearly the same, the composition changed. The current carrier vehicle has fewer expensive components and more inexpensive components. Elimination of redundancies warranted the removal of the fire control sensor and the BM/$C^3$ functions. These payload deletions along with their associated equipment have reduced requirements on every carrier vehicle subsystem and significantly reduced program risk.

Interceptor: A key SBI driver is the focal plane array (FPA). We are now working toward an improved technology that will be more producible and affordable based on results from recent laboratory accomplishments. The key to these advances is the ability to produce "chips" of the proper material in the proper configuration. These chips improve performance so that a lighter projectile can be produced. The lighter projectile makes it feasible to resize the rocket motors, and thus increase the velocity, range and effectiveness of the interceptor. The increase in motor weight is an extra load on the carrier vehicle structure, but these are very inexpensive components on a weight basis compared to the rest of the system. The estimated cost of the FPA is based on history and progress in technology development.

High Rate Production: The SBI carrier vehicle will be the first satellite to be produced in numbers comparable to aircraft or weapon system production. The simplification of the satellite has reduced the risk of unforeseen problems during the development phase, and it enables us to plan a more economical production program as well.

TABLE III-2. PRIMARY SDS PHASE I COST DRIVER CHANGES

| PARAMETER | % OF JUNE BASELINE | CHANGE RATIONALE |
|---|---|---|
| SBI | | $52.0 B (88) → $17.7B (88) |
| FIRE CONTROL SENSOR | 0% | • REDUNDANT TO OTHER SENSORS |
| INTERCEPTOR WEIGHTS<br>• PROJECTILE<br>• MOTOR STAGES | <br>59%<br>315% | <br>• ENABLES VELOCITY INCREASE/COSTLY<br>• FOR VELOCITY/INEXPENSIVE |
| INTERCEPTOR APERTURE | 70% | • FOCAL PLANE ARRAY TRADE |
| CARRIER VEHICLE WEIGHT<br>• DRY (NO PROPELLANTS)<br>• TOTAL | <br>92%<br>97% | <br>• HEAVIER INTERCEPTOR PAYLOAD, BUT LESS COMPLEX |
| COMMUNICATIONS/ PROCESSING WEIGHT | 30% | • BM/C3 REDUNDANT TO SSTS |
| ELECTRICAL POWER | 25% | • EQUIPMENT REDUCTIONS |
| QUANTITIES<br>• CONSTELLATION<br>• PRODUCTION | <br>49%<br>47% | • WEAPON REALLOCATION<br>• IMPROVED PERFORMANCE<br>• REDUCED PRODUCTION RISK |
| SSTS | | $12.6B (88) → $9.2B (88) |
| APERTURE | 50% | • MISSION REDUCTION<br>• MANAGE SENSOR REDUNDANCY |
| DETECTORS | 10% | • REDUCED APERTURE<br>• MISSION REDUCTION |
| SIGNAL PROCESSING | 13% | • REDUCED DETECTORS |
| DATA PROCESSING | 23% | • REDUCED DETECTORS |
| ELECTRICAL POWER | 43% | • EQUIPMENT REDUCTIONS |
| SATELLITE WEIGHT<br>•DRY (NO PROPELLANTS)<br>•TOTAL | <br>53%<br>87% | <br>• INCLUDES NEW INTEGRAL STAGE<br>• ORBIT INSERTION PROPELLANT |
| QUANTITIES<br>•CONSTELLATION<br>•PRODUCTION | <br>150%<br>157% | <br>• COMMUNICATIONS DRIVEN |
| BSTS | | $9.2B (88) → $8.0B (88) |
| QUANTITIES<br>•CONSTELLATION<br>•PRODUCTION | <br>75%<br>80% | • REDUNDANT SENSOR CAPABILITY |
| ERIS | | $4.8B (88) → $5.8B (88) |
| QUANTITIES<br>•DEPLOYED<br>•PRODUCED | <br>170%<br>163% | • WEAPON REALLOCATION<br>• REDUCED RISK |

Several new technologies have been used to improve the SBI, ranging from improved propulsion to enhanced seeker focal plane materials. However, none of these advances has been achieved spontaneously. They are the result of parallel advanced technology programs that have been seeking better capabilities at lower cost for several years. Current SBI designs take advantage of expected technology developments in which we have high confidence. We anticipate that, as they mature, these and several other technology developments will continue to provide performance augmentation options for the system elements.

The SSTS acquisition cost decreased from $12.6 billion to $9.2 billion. This resulted from the combination of a significant decrease in individual satellite capability and cost, and a relatively smaller increase in constellation size. The net effect is a less expensive system which continues to support architecture sensing and coverage requirements. As with SBI, the opportunity for a reduction in the SSTS sensing capability occurred because of redundancy within the overall architecture. The combined sensing capabilities of GSTS and GBR, as well as the sensor on the ERIS interceptor, allowed reductions in SSTS capabilities without compromising SDS effectiveness. The scaleback of SSTS was accomplished by a 50% reduction in aperture size and the elimination of 90% of the number of the detectors, allowing corresponding reductions in satellite structure, processing, and other subsystems. This combination of effects resulted in the significant decrease in SSTS costs.

BSTS's acquisition cost decreased from $9.0 billion to $8.0 billion between the June and October estimates. The cost reduction resulted from a reduction in constellation size and a technical reassessment of the FPA as described earlier for SBI interceptor cost impacts. Although the change has decreased the sensing capability of the BSTS constellation, the reduction did not lead to a decrease in military effectiveness. Analysis of previous architecture concepts showed there was an excess of sensing capability relative to weapon capability -- the sensors could acquire more information than required. The removal of this "excess" sensing capability reduced costs without a corresponding degradation in overall system effectiveness.

The cost of the ground-based ERIS increased from $4.8 billion to $5.8 billion between June and October, because of a decision to utilize more ground-based interceptors. The increased capability of the space-based interceptors allowed its numbers to be reduced even further than the compensating quantity increase in ERIS without impacting the SDS mission. The increased ERIS cost is due to a 70% increase in interceptor inventory along with parallel increases in launchers, support facilities and personnel. Due to the large amount of non-recurring cost in the estimate, which is independent of quantity, this equates to only a 21% increase in total acquisition cost.

A second SDS element to experience a slight cost increase between the June and October DAB reviews was GBR. The increase, from $2.7 billion to $3.1 billion, resulted from minor programmatic changes relating to schedule, and new cost data received from the contractor for the experimental version of the radar (resulting from the pending expansion of GBR from a terminal only sensor to a midcourse/terminal sensor.) GBR is not currently approved as an element of Phase I. It is under consideration and included here for architecture analysis purposes.

GSTS did not experience any significant technical or programmatic changes. The cost of GSTS declined slightly from $3.6 billion to $3.3 billion, due to a reduction of flight testing in favor of more ground testing and a reduction in the effort to be provided by a second source contractor.

In the BM/C3 area, major changes in the operational concept and hardware definition resulted in a 50% acquisition cost reduction. The key modifications were: change in the size and acquisition strategy for obtaining a dedicated SDS fiber optics network; a reduction in the estimated real-time software requirements; elimination of an Airborne Command Center (ACC) component; and, utilization of a larger number of existing ground segment command centers.

The Systems Engineering & Integration (SE&I) acquisition costs were reduced by 36% due to significant changes in the functions of the SE&I segment. These included a reduction of overlapping integration and test software development efforts, a reduction in centralized integration facilities and hardware (versus distributed facilities to the elements), elimination of centralized training and training software development, and the elimination of the requirement for centralized integration and simulation hardware.

Mr. MCCURDY. Of course, your cost is now 50 to 55 billion. There were reports yesterday of a letter from General Abrahamson to someone that was on the news last night that indicated that he felt—I don't know—that a $25 billion system was in order. Is that an accurate description of such letter?

General MONAHAN. I believe he did say that, in the paper that I read.

Mr. MCCURDY. To whom was the letter written?

General MONAHAN. What you are quoting from is his end-of-tour report that he sent to the Deputy Secretary of Defense.

Mr. MCCURDY. Was it a classified document?

General MONAHAN. I don't believe so.

Mr. MCCURDY. Oh, here it is. Trusting staff always has everything.

What he says is, "Adding BSTS to the system as a replacement for DSP and a redundant warning capability along with the required command and control capability would add 15 billion, for a total of research development and deployment costs for approximately $25 billion." Is he just talking about Brilliant Pebbles?

General MONAHAN. I think I would have to reread exactly what it was he said because I read that—the end-of-tour report, a few weeks ago. First of all, he is talking about Brilliant Pebbles, but then he is talking about other sensor and command and control elements that would have to go along with that. I think he is including the BSTS, for example, although I can't recall for sure.

Mr. MCCURDY. So when——

Mr. KYL. Excuse me, if the gentleman would yield, I think I can shed some light on that.

He has two total costs. First of all is the cost of the phase 1 system that would include a space-based component. That is $25 billion, comprised of three things: $10 billion, approximately, for the Brilliant Pebbles component; $11 billion for the surveillance satellite and telecommunications portion of it; and $4 billion for the support structure ground command and control. That total is $25 billion.

Then, for the ground-based portion of that, with which you are familiar, there is an additional $25–$30 billion, for a total of $50–$55 billion.

Mr. MCCURDY. So he is basically saying that your numbers, $50–$55 billion as a cost goal for a SDS system is consistent with what this letter is. This is no new revelation then? He is saying it is a total system of $50–$55, or is he saying, no, he disagrees with your $50–$55 number and saying it could really be for $25 billion? I am confused here.

General MONAHAN. I really don't know the answer to that, either, Mr. McCurdy.

Mr. MCCURDY. Does the gentleman from Arizona know?

Mr. KYL. It is just a matter of two components. In his letter, he describes the space-based component, with all of its bells and whistles, would be $25 billion. Then add the ground-based component for another $25–30 billion. Add them together; you have the total of $50–$55 billion.

Mr. MCCURDY. So the reports on the news last night were somewhat exaggerated, which is not unusual, but—in saying that they

really felt that it could be done for $25 billion, which seems to be—for a total system would be unrealistic. I mean, you have no knowledge whatsoever of a total phase 1 system that could be built for 25 billion, right?

General MONAHAN. Phase 1 system, as it is laid out here, clearly could not.

Mr. MCCURDY. What is your best guesstimate of the phase 1 cost?

General MONAHAN. Sixty-nine as of the moment. As we press forward and try to do better in the research arena—one of our major goals in the program is to get the cost down. I don't know how low we can get it, but——

Mr. MCCURDY. Can you give me the figures on the BSTS, what your best figure is for just that portion of it? Is that consistent——

General MONAHAN. For the BSTS part of the program? In 1988 dollars, it is a total of 8 billion and that is research, development, acquisition costs.

Mr. MCCURDY. Eight billion? How many deployed, and again, interrupt me if I get into an area we need to discuss in classified session.

General MONAHAN. It is six BSTS deployed.

Mr. MCCURDY. This is a multispectral system and all the bells and whistles?

Mr. DELLUMS. Would the gentleman yield just for one quick second?

General, would this BSTS provide battle management capability, and if so, would that capability then make this nontreaty-compliant?

General MONAHAN. BSTS perhaps could. We haven't arrived at all those decisions yet. We are still on the demonstration/validation phase, so the final spec isn't written.

Mr. DELLUMS. I thank the gentleman for yielding.

Mr. MCCURDY. Certainly.

Again, I have to be careful here, but I am somewhat concerned. I have two other committee assignments. One is the Science and Space Committee and the other is the Intelligence Committee. Having some knowledge of satellites systems and the cost of those, at least from the cost standpoint that we are always being presented with, I find a rather ambitious undertaking for a total system with that capability within those costs.

Are you telling me that this is again some technology breakthrough or——

General MONAHAN. No.

Mr. MCCURDY. Perhaps at some stage, we could go into a classified arena and you could show us in a little more detail what you—how you are going to pull this off.

General MONAHAN. Right. I think, Mr. McCurdy——

Mr. MCCURDY. I mean, launch costs alone are running in the hundreds of millions of dollars these days.

General MONAHAN. Certainly. Satellites have an average cost about $20,000 a pound, historically. Except GPS, I think we got it down to 10,000 because we finally bought a bunch in a roll.

I feel good with the $69 billion estimate. Why? Because it was developed from the bottom up. It came from the people who are going to develop it to begin with. So it came from the Army and

the Air Force and the other elements, the other agents. That is the first thing.

The second thing is it was subjected to an independent review conducted by the SDI Organization and then another independent review by the cost analysis group in the Pentagon. So it went through the formal rigorous cost-estimating procedure and then went through all the various checks associated with it.

I don't know how you——

Mr. McCURDY. What year dollars are you using?

General MONAHAN. Those are fiscal year 1988.

Mr. McCURDY. In the January 23rd issue of Aviation Week, officials—Grumman said that BSTS would cost roughly 30 billion over several decades. Is that——

General MONAHAN. Thirty billion over several decades?

Mr. McCURDY. Yes.

General MONAHAN. OK.

Mr. McCURDY. Life-cycle versus—you guys come up here and you give us 1988 dollars versus 1990. I don't know the numbers here.

General MONAHAN. I gave you—what I gave you there for BSTS were the costs to do phase 1, phase 1 on the program, which is the first six BSTSs. If you are going to keep BSTS going another 50 years, obviously you will spend a lot more money.

Mr. McCURDY. So you are saying an initial deployment of a complete system, even though it is not life-cycle—long-term, would be, what, number six to nine?

General MONAHAN. Eight billion dollars for the first six BSTS systems and that does not include operating and support costs and does not include anything beyond those first systems. I believe the number six is correct.

Mr. McCURDY. That is both ground and——

General MONAHAN. It buys three spares, so that is a total of nine support systems.

Mr. McCURDY. We would like to see some specific breakdown for that.

Just one last question. On your strategic review that is ongoing, the—as of this stage, there has not been a decision on a ALPS versus a phase 1—I mean, you still maintain that phase 1 is your deployment scenario that you prefer. Is there discussions within the strategic review or have you been tasked by whoever is in charge over there right now to come forward with an ALPS review?

General MONAHAN. Some of the options that we have under consideration in the strategic review do include ALPS as part of it.

Mr. McCURDY. When will that review be forthcoming?

General MONAHAN. I don't know what the final schedule is. I mentioned earlier I think within the Organization, we should have most of our work done this month. Then it has to go forward for further reviews.

Mr. McCURDY. Including budget numbers or have you already submitted those?

General MONAHAN. No, we are working budget numbers at the same time.

Mr. McCURDY. Were you given a fair hearing, as they say? Are you exempt from all the Bush bogies?

General MONAHAN. I don't know that I am exempt from anything, but I have not been given any bogies.

Mr. MCCURDY. You specifically examined—I mean, when they said, "DOD come up with a 2 percent reduction or whatever," SDI was exempt——

General MONAHAN. We did not participate in that exercise, right.

Mr. MCCURDY. Thank you.

Thank you, Mr. Chairman.

Mr. DELLUMS. The gentleman yields back his time.

Mrs. Byron is recognized for such time as she may consume.

Mrs. BYRON. Thank you, Mr. Chairman.

General, let me follow along on the funding and the budget aspect, because over the last 5 years, you have been under-funded each year, although last year you came the closest to the requested funding.

How long can you under-fund a system in a development stage and stretch it out again and again, to keep the program alive, and to keep your technical team together. Is it not better to regroup, draw down, narrow the scope and operate within the funding levels that have been given you?

General MONAHAN. I think if you keep having the wild swings all the time and you don't get the stability, before very long, people are probably going to start losing interest. An awful lot of the value that we get out of the program is—the American industry, noting that the United States Government has an interest somewhere and is willing to press on after a certain program, tends to put an awful lot of their own resources into it. We reap a benefit from that and it is kind of a benefit that we don't pay for, at least indirectly, so that is something that would be affected.

Mrs. BYRON. I think I would be less than candid to say that the SDI program is somewhat battered. I look in the future, and I think that is one of the missions that this subcommittee has down the road, and I am looking for some vehicle that we can excite the younger generation to take the courses early on to get the advanced degrees, to put in the commitment to want to go to be a part of it.

We saw that in the 1960s when many of you—I am sure your teen came home and said I want to be part of that group that is going to go to the moon. I don't see anybody coming home and saying, I want to be part of SDI when I grow up.

At what point—and this follows on the chairman's comments and line of questioning—at what point do we have to make the decision to go nuclear or non-nuclear? I had asked this question previously about 3 or 4 years ago and the answer I got at that time was, oh, it is way down the road. Well, we are 3 or 4 years later and I envision a serious problem with a large number of members if you bring in that buzz word as part of the system.

General MONAHAN. As I mentioned earlier, to do the entire phase 1 program, there is nothing nuclear that has to be done at all. Indeed, if you stay with the kinetic kill vehicles, both space-based and ground-based, there is no reason in the world to have anything nuclear associated with SDI. The possibility of nuclear occurs when considering Space-Based Laser and whether a nuclear reactor be required to power a Space-Based Laser.

We don't know the answer to that yet, but that is a possibility. There was also, at one time, some notion that perhaps x-ray lasers, which would derive from a nuclear event, would be an effective directed-energy weapon in space. But again, nobody really has to go there.

So, other than that, as I said, the only time that you would be faced with such a decision is, first of all, if we, as a nation, decided we would put directed-energy weapons in space and decide to do that. Then we should know at about the same time whether or not nuclear power would be required for them.

Mrs. BYRON. I have one final question and that is, it seems to me, looking at the battle that we have year in and year out on the ASAT program, it is going to be very difficult to get that step done. But it also seems to me to go from point A to point C, you have to stop off at point B and point B is ASAT. Would it not be more cost-effective to combine the two programs?

General MONAHAN. No, I don't believe that it would, to tell you the truth. Obviously, both programs can probably use some bits and pieces from the other, but they really have quite different missions to perform.

Mrs. BYRON. Thank you, Mr. Chairman.

Mr. DELLUMS. The gentlewoman yields back the time.

Mr. Weldon has returned and the Chair would like to provide the gentleman an opportunity to question and yields to the gentleman such time as he may consume.

Mr. WELDON. I thank you, Mr. Chairman, for yielding and I apologize for having to leave. I have hearings going on at three different committees at one time.

Just one line of questions I want to pursue relating to the ABM pre-discussions. As we all know, any discussion of a treaty requires adherence on both sides and one of my concerns is that while we were talking extensively about SDI as a potential breakout for our country on the ABM Treaty, that we have acknowledged on various occasions that the Soviets have been in violation of this same treaty in several situations, not just with their own work and potential work on SDI, which 10 years ago they were openly denying. As recently as 5 years ago, in discussions I have had in Moscow, they were denying that they were doing any Soviet work on SDI technology, yet our intelligence was telling us something different by the photographs that we have of laser generators and particle beam operations that we had seen were being developed in their country.

Last week, Andre Kokoshyn testified before our Defense Policy Panel and admitted that the Soviets have been, in fact, exploring their own SDI as recently as 6 years ago, but in his terms, they had given up on the technology, which I find somewhat hard to believe. My point is that any discussion of the ABM Treaty and the potential for SDI operations to have us break out of that treaty has to also be looked at in light of what the Soviets, in fact, are doing along the same line.

One of the things that has bothered me is that I have felt, in my 2½ years in Congress, that we haven't always had access to the full information about Soviet ABM compliance, as well as potential for Soviet ABM breakout.

On last year's defense bill, I included a piece of legislation that requires DOD to come up with a report, a classified and unclassified report, on the potential for Soviet ABM breakout. I would like to have you, if you would, General, check into the status of that because I have not received it yet, and I would also like to ask you, Mr. Chairman, if you would, to consider holding a confidential closed briefing for members of this subcommittee on what the Soviets are doing in the area of SDI work. Using our latest available intelligence, I had arranged a similar briefing in the last session and had about seven members of the Armed Services Committee sit through a briefing by defense intelligence and Air Force intelligence. I think an updated version of that would be useful to us as we consider SDI, both from our standpoint and from the Soviets are doing in this year's round of discussions and debate.

Mr. DELLUMS. If the gentleman would yield, the ranking minority member, Mr. Dickinson, already pursued this general line of questioning and we have informally agreed that we would create a forum that will allow this kind of classified information to come to all the members of the subcommittee.

Mr. WELDON. I thank the chairman and I will yield back the rest of my time. Thank you.

Mr. DELLUMS. The gentleman yields back his time.

Does the gentleman from California, Mr. Hunter, seek recognition?

Mr. HUNTER. Thank you, Mr. Chairman.

Just a fast question and I thank you very much, Mr. Chairman, for allowing me to come in late in this hearing. I apologize. I, too, have a number of committees going.

It appears to me that war-fighting scenarios in the way the world works and history works, that usually the truth is stranger than fiction and I recall a couple of years ago, we were looking over the possible conflicts in the world, where conflicts might appear, the Falkland Islands situation was the furthest from any of the perceived problems or expected problems, and yet, that is where we saw a major conflict.

In the same sense, it appears to me that of the nations that are on their way to gaining ballistic missile capability, probably the one we are preparing most strongly against, the Soviet Union, is not as inclined, at least at this time, to strike the United States as some other nations are, may be or possibly will in the future.

I think it is very important that our SDI program fit the threat, I guess is what I am saying. I just wondered, General, how many nations are going to have ballistic missile capability by, say, the year 2000? Do you have any reading on that? Aside from the Soviet Union and China?

General MONAHAN. It is quite a few, Mr. Hunter. I don't remember the number itself, but I can get it for you.

Mr. HUNTER. One thing that I am concerned about is that if we are going to, indeed, move ahead, I think we should move ahead and we should build a system. I think if you can't stop missiles, you can't defend your country, but I think it is important that we build to the threat and fit the threat.

I wonder if you could get for the record, with the indulgence of the chairman, an analysis of the holders of ballistic missile capability by the year 2000 and maybe shortly beyond for this?

General MONAHAN. I would be happy to do so.

Mr. HUNTER. Mr. Chairman.

Mr. DELLUMS. Yes, without objection.

[The following information was received for the record:]

Answer provided in SECRET addendum to transcript.

Mr. HUNTER. Thank you, Mr. Chairman.

Mr. DELLUMS. The Chair would note that it is a little after 12:00, but sometimes we have gone to 12:30. The Chair would like to indicate to the gentleman from Arizona that he said that, time permitting, he would be happy to yield to the gentleman for any follow-on questions. If the gentleman wants to ask questions, the Chair would yield to the gentleman for that purpose.

Mr. KYL. Thank you, Mr. Chairman.

I would like to note that I, too, had hearings this morning, but I stuck it out here because you are here, General Monahan, and I wanted to be here with you this morning.

Mr. DELLUMS. The gentleman is always there.

Mr. KYL. In view of the time, I would simply like to quickly go back over one subject and then I am sure we will have other opportunities to get together, because both you, Mr. Chairman, and Mrs. Byron, who is no longer here, were concerned about the nuclear components.

I just want to quickly understand this. It is true, General Monahan, that the Soviets do use nuclear power in space now and that we do not; is that correct?

General MONAHAN. That is correct.

Mr. KYL. It is also true that their ABM system or at least part of their ABM system—uses a nuclear warhead and we don't have any such——

General MONAHAN. I believe, yes, that is true.

Mr. KYL. Third, their long-term research, as ours, does in part look at some nuclear components primarily for power purposes, but perhaps even theoretically a laser for weapon way down the road. Is that correct?

General MONAHAN. They could. It could be.

Mr. KYL. Is it also true that part of the reason we research these things is so that we can understand what the Soviets might be doing—not necessarily to deploy a system ourselves.

Fourth, that all of our phase 1 defense, you said, is non-nuclear as it is proposed.

General MONAHAN. Yes, that is true.

Mr. KYL. This isn't necessarily your area, but I think you—and we all know the answer to this question—is it not also true that all of our strategic offensive deterrent is nuclear?

General MONAHAN. The word "all" gets to be——

Mr. KYL. An awfully large part of our strategic offensive deterrent is nuclear.

General MONAHAN. You have to be at least 99 percent correct with that statement.

Mr. KYL. As Perry Mason says, Mr. Chairman, "I rest my case."

Mr. DELLUMS. The gentleman yields back his time.

General, we talked informally in our introductory meeting about the relationship between SDI and ASAT. I would like to bring you to that issue on the record.

In your prepared remarks, you spoke of protecting the SDI components from ASATs and would you please explain how this will be done. My follow-on question is this: If it can be done to protect components of SDI, why couldn't the same measures be taken to protect our satellites, therefore removing the need to develop ASAT? However, if SDI components can't be fully protected from ASAT, wouldn't that mean that a fully deployed ASAT program would render SDI vulnerable and therefore not survivable?

General MONAHAN. OK. Let me just do my best that I can to answer that without trying to get classified.

I think you would have to look at it philosophically that there is probably no such thing as a perfect ASAT; there is no such thing as an absolutely perfect satellite system that is immune from an ASAT either.

Mr. DELLUMS. Let's contemplate a laser ASAT program.

General MONAHAN. OK, but even with a laser ASAT, I believe that you would have ways to counter lasers, so—just because a laser ASAT may be one way of doing a job, there are ways—like I say, I want to keep from getting classified here, but there are ways to develop countermeasures against lasers also. So that part of it is not hopeless.

I don't think you can talk very definitively one way or the other on the subject, and I think there would be a give and a take. We have electronic warfare equipment that has been constantly updated over the last 30, 40 years that—it operates—certain of the radio frequency equipment radars, et cetera, can operate very well on certain jamming environments. Other jamming environments, they can't work quite as well. It is a system of measures, countermeasures and counter-countermeasures. I think you are looking at the same thing here when you look at ASATs and also look at satellites.

But when you have one side, the reason for the high priority on ASATs, of course, is that the Soviets have that capability today, and they can take down a lot of our satellites we have up there today, but theirs go scott free as of present time. We don't have a way to fight back. So that is what is behind the ASAT priority.

Mr. DELLUMS. Does the gentleman from Pennsylvania have any additional questions?

Mr. WELDON. No.

Mr. DELLUMS. If not, General, we would like to thank you for your presentation this morning.

We appreciate your presentation this morning. The Chair would like to indicate to my colleagues that we will meet tomorrow morning at 10 a.m., in 2118, where the subject matter will be the ASAT program.

The subcommittee stands in adjournment until that time.

[Whereupon, at 12:15 p.m., the subcommittee was adjourned, to reconvene at 10 a.m., Wednesday, March 15, 1989.].

[The following questions were submitted to be answered for the record:]

Mr. HUNTER. General, how many nations are going to have ballistic missile capability by, say, the year 2000? Do you have any reading on that? Aside from the Soviet Union and China?

General MONAHAN. By the year 2000, [deleted] countries will either have produced or be able to build ballistic missiles [deleted].

More difficult to project are purchases or transfers of complete ballistic missile systems, [deleted] most of these countries will equip their ballistic missiles with conventional warheads. However, we judge that many of these proliferating ballistic missiles could be armed with improved conventional munitions [deleted].

# ANTI-SATELLITE [ASAT] PROGRAM: RDT&E BUDGET REQUEST FOR FISCAL YEAR 1990

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Wednesday, March 15, 1989.*

The subcommittee met, pursuant to call, at 10 a.m., in room 2118, Rayburn House Office Building, Hon. Ronald V. Dellums (chairman of the subcommittee) presiding.

## STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The subcommittee will come to order.

This morning the Research and Development Subcommittee will take testimony on the anti-satellite program.

Our witnesses will be Gen. John L. Piotrowski, Commander in Chief, U.S. Space Command, and Mr. Frank Kendall III, Acting Deputy Undersecretary Of Defense, Tactical Warfare Programs.

For the past several years the administration and the Congress have had a difference of opinion on the development of the F-15 based ASAT system.

That program has now been canceled. A new program is being proposed in the fiscal year 1990 budget request to evaluate systems using both kinetic energy and directed energy.

To begin this program, I have heard requested numbers that range from $100 million to $200 million. This program is also benefiting from SDI programs that have direct applications for ASAT development.

It is our hope that the witnesses will shed some light on exactly how much money is being requested, and how this money will be used. What are the policy implications of deploying an ASAT system? What is the purpose of our ASAT program? How will our satellites be more secure after development of ASAT than they are now? How would a workable ASAT system affect the survivability of a strategic defense system? My sense is that we are more militarily dependent at present on satellites than the Soviets.

As such, are we not more at risk if both sides pursue an ASAT race than if we move to a moratorium on ASATs? These are but a few of the areas I hope to pursue this morning.

However, before we begin I would like to yield to the subcommittee's ranking minority member, the Honorable William L. Dickinson, for such time as he may consume.

**STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER OF THE RESEARCH AND DEVELOPMENT SUBCOMMTTEE**

Mr. DICKINSON. Thank you, Mr. Chairman. Thank you gentlemen for your appearance here today. I notice all the different uniforms sitting in the first row there showing a unanimity of purpose here. A lot has happened with ASAT in the past year—DOD canceled the F-15 MHV program and then the House reversed itself by rejecting a permanent testing moratorium and establishing a new ASAT program.

Consequently, we look forward to your testimony on where we are with the ASAT program.

Former Secretary of Defense Carlucci recently published an editorial in the LA Times. I quote part of it: "There is one area which we have left a significant gap in our deterrent posture, the lack of an effective U.S. anti-satellite, or ASAT capability. I believe this is the single most serious deficiency in our military posture."

Secretary Carlucci was correct to refer to the nonexistent U.S. ASAT capability as our military Achilles heel. While the military requirement for a U.S. ASAT continues to mount, its importance is too often obscured in the rhetoric of the political debate.

However, the primary reason the House rejected the 3 year old ASAT testing moratorium last year was the Department of Defense's, and in particular, General Piotrowski's concerted efforts to ease the classification level of certain intelligence data on Soviet satellite and ASAT capabilities.

After presenting this information and explaining the military requirement for a U.S. ASAT to a large number of members, more than 200 of us in the House voted to reject any further limitation on testing. I hope the facts continue to influence the House's approach toward this new ASAT initiative.

It concerns me that many of my colleagues have opposed U.S. ASAT efforts on the grounds that if we don't deploy ASAT then the Soviets won't either and stability will be enhanced.

However, in reality, we do not have a deployed ASAT capability yet the Soviets continue to develop, test and operate a wide variety of ASAT-capable systems. But even if neither side had ASATs and this could be verified, the Soviet overhead satellite threat would still drive the military requirement for a U.S. ASAT.

Last year a highly respected report was issued by the bipartisan Commission on Long-Term Strategy entitled Discriminate Deterrence. When the likes of Henry Kissinger, Fred Ikle, Zbigniew Brzezinski, John Vessey and Albert Wohlstetter all agree on the need for a U.S. ASAT capability, we should pay close attention. The report stated that in conducting a conventional attack, the Soviets would use their own satellites as an essential support for their military operations. So we need the means to degrade Soviet satellites, not simply in reaction to Soviet attacks on our satellites, but because they will use theirs to acquire and distribute information in support of land, sea and air forces attacking our air, land and sea forces.

Just as we need both tanks and anti-tank missiles, so we will want active and passive defense of our satellites, means of replen-

ishing them in wartime and ways of degrading an enemy's satellites.

In a war with the Soviet Union, we cannot count on space being a sanctuary; more likely it would be a critical battlefield.

The Commission therefore concluded that at a minimum the U.S. needed, a capability in wartime to disable hostile satellites at all altitudes.

Thus, between last year's House vote and reports like Discriminate Deterrence, it appears that a bipartisan consensus has emerged on our need for ASAT. If so, the task at hand is to rationally proceed with the development and deployment of an effective ASAT capability. I hope this process begins with today's hearing.

Thank you very much, Mr. Chairman.

As I said at the inception of my remarks, I think the more we are able to get word out as to the Soviet capabilities, the more we can convince our colleagues in the Congress of the need for us to at least parallel the Soviets efforts and develop one of our own.

I think that is one of the most important things that we have facing us in the new budget year. So thank you for your presence here. We look forward to your testimony.

Mr. DELLUMS. General Piotrowski and Mr. Kendall, we would like to welcome you before the subcommittee. Without objection, the full text of your statements will appear at the appropriate point in the record. You may proceed in any fashion you choose.

## STATEMENT OF GEN. JOHN L. PIOTROWSKI, USAF

General PIOTROWSKI. Mr. Chairman, distinguished Members, I welcome this opportunity to present information on the critical need for a U.S. anti-satellite capability.

The United States has consented to the Soviet Union control of space. The Soviets not only have multiple systems with which they can degrade and destroy our vital satellites, but they have a large robust and responsive space infrastructure that enables them to launch large numbers of surveillance and warfighting satellites at will.

For example, during the Falklands war, the Soviet Union conducted 29 launches in 69 days. This is more launches in just over 2 months than the U.S. has achieved in 3 years. More importantly, there is evidence that many of these launches were not preplanned, but these warfighting spacecraft were placed in orbit in response to the Falklands conflict.

This was not an aberration of their capability. The Soviets have demonstrated the ability to launch spacecraft in rapid order for extended periods on several occasions.

These impressive demonstrations of Soviet launch responsiveness and operational flexibility also infer enormous stockpiles of war reserve space boosters and payloads.

What this all points to is they have the resources and the means to put large numbers of gunsights in space that can directly target our ships, our solders and our airmen in crisis or in conflict.

On the other hand, while U.S. technological superiority enables us to field longer lived, finer grained, highly sophisticated payloads, the infrastructure that supports them is very thin and not

responsive to operational needs. Nor does the United States have war reserve stockpiles standing ready to replace wartime losses.

Our long-standing concept, by inspection, has been to support combat operations here on earth, with whatever space assets are operational at the time.

As just one example of our inability to launch on demand, one of our most critical space constellations—the geosynchronous satellite early warning system that detects, tracks and warns of Soviet missile launch—needs a replacement.

A replacement should be launched at once, but has been delayed for at least 6 months. This satellite, which is sorely needed now, will not be operational until later this year even if the launch goes as currently scheduled.

The facts are—while our spacecraft are far superior—we are in a situation where the Soviets can, in a crisis, blind them or destroy them at the same time they are rapidly increasing the number of their communications, surveillance and targeting satellites—and we do not have the sources or means to replace our potential losses in weeks or even months.

The United States is in the worst of all positions vis-a-vis the Soviet Union in space.

They have a robust responsive infrastructure—we don't.

They give clear evidence of a warfighting attitude in space—we shun such notions.

They have the ability to deny, degrade and destroy our satellites—we have no capability against theirs.

Thus we have abdicated space control to the Soviets and as a result place our forces at a much greater risk.

With regard to anti-satellite weapons, there are three possible scenarios:

1. The Soviets have them and we don't—which is the current situation and—I believe—very destabilizing.

2. Both the Soviets and the U.S. have anti-satellite weapons which many would argue is stabilizing in other forms of weaponry.

3. Neither side have ASAT weapons--which has been suggested as the course to pursue through negotiations.

While many would agree with the latter course in principle, it does not make sense because of assymetries in space systems as well as in our general force posture.

We are, for example, by and large, a maritime nation that must forward deploy significant forces in time of crisis—all easily targeted by Soviet EORSATS and RORSATS. Moreover, I do not believe, even if a non-ASAT treaty was in our interest, that some existing capabilities will not be given up by the Soviets. More importantly, the absence of an ASAT capability is unverifiable because it is inherent in so many treaty compliant systems.

One such treaty compliant system is the Soviet's antiballistic missile system. General-Major Yuri V. Lebedev, Deputy Chief of the Negotiation Directorate of the Soviet Union General Staff, said in July, 1987, "Guided missile interceptors are designed to defeat not only missiles but spacecraft as well. This means that they can carry out both defensive as well as offensive functions. They can conduct the battle for supremacy in space."

Mr. Chairman, the United States desperately needs a highly capable ASAT to deter Soviet aggression in space and on earth. In the first instance we must be able to destroy Soviet satellites that target our forces should deterrence fail. Absent an ASAT, our forces and the outcome of conflict are at increased risk.

I am happy to respond to any questions you may have.

Mr. DELLUMS. Thank you for your opening remarks.

Mr. Kendall, do you have an opening statement?

## STATEMENT OF FRANK KENDALL, III, ACTING DEPUTY UNDER SECRETARY OF DEFENSE

Mr. KENDALL. Yes, sir.

Mr. Chairman, distinguished Members of the committee, in view of the continued need to project power, to deter war and to control escalation during conflict, the Department feels that it is essential for the United States to develop and deploy an operational ASAT to deter the Soviets from exploiting their present space control and space-based targeting capabilities. As a result, the President's budget contains a sizable multipronged program that will provide an initial U.S. ASAT operational capability in the mid-1990s. I would like to describe that program to you in general terms.

The requirement for an operational U.S. ASAT system has been developed over the past 25 years and is now embodied in documents approved by the Defense Acquisition Board [DAB] and validated by the Joint Chiefs of Staff. No currently envisioned single ASAT system can meet this set of requirements which are very challenging.

As a first step toward fulfilling these requirements, a near-term set of performance goals was developed and approved by CINCSPACE in July 1988, to be applied as we acquired near-term ASAT weapon systems.

The specifics are classified, however, they are focused on negating the highest priority targets, particularly the satellites that threaten our sea and land forces. All of these targets are in low earth orbit. They do not include the high altitude early warning satellites. Our ASAT program and budget are presently structured to address these CINCSPACE near-term performance goals.

The requirement for a mix of U.S. kinetic energy and directed energy ASAT capabilities evolved from DOD studies of the potential diversity of threat responses, specific ASAT system capabilities, differing conflict scenarios, and total system cost considerations. Additionally, there is real technical and operational synergism between kinetic and directed energy weapons.

Kinetic energy interceptor weapons are our first priority for low altitude ASAT because of the following positive characteristics: They typically have long lateral coverage at low altitude, where many key targets orbit, thus providing more potential for early engagements and significant cross range capability. They are not limited by weather. They produce catastrophic destruction of the target upon intercept, so that target hardening is all but impossible and a kill is easily verified.

The major drawbacks of kinetic energy systems are a fixed number of bullets once production is ended and a well-defined altitude limitation.

On the other hand, ground-based lasers offer complementary advantages in that they have an essentially unlimited number of bullets or shots, can rapidly respond to counter target maneuver based on local acquisition and speed of light delivery, and have a gradual [versus sharp] fall off in lethality with altitude.

The inherent weaknesses of cloud cover limitations, target hardening potential and shorter cross range at low altitude are directly complemented by the kinetic energy interceptor.

Our near-term ASAT program is the result of several major studies within the DOD, with inputs from OSD, the military departments, operational commanders and the Joint staff. The program relies on upgrades to the supporting space surveillance network, as well as the mix of ground based kinetic energy and directed energy weapons I've previously discussed.

Both the kinetic and directed energy weapon programs leverage heavily upon the Strategic Defense Initiative Organization's technology and research efforts.

This has been done to eliminate redundant technology development programs and to keep total ASAT system procurement costs at a minimum.

In the current budgetary environment, we would be remiss if we ignored the fact that many of the technologies under development in SDI can also have application for ASAT.

As to the specifics of the program, the Air Force is the lead service for a single comprehensive space surveillance and battle management/$C^3$ system that will control all ASAT capabilities and weapon systems. The Air Force is responsible for coordinating the integration of those weapon system elements with the kinetic and directed energy ASAT weapons programs offices.

The Army is the interim lead for the kinetic energy weapon system and is establishing a joint program office, with the Navy and Air Force, to develop, test, and produce a kinetic energy ASAT interceptor derived from the midcourse interceptor program being developed under SDI. Both ground-based and ship-based versions will be considered for development.

At Milestone I, now planned for late 1989, the Department will review the lead service responsibility as well as the options for sea and land based kinetic energy ASAT versions.

For directed energy weapons, no joint program office has been created. The Army and Air Force are independently investigating various directed energy technologies. The Army is including an ASAT capability in the design and development of the SDIO's Free Electron Laser, at least through fiscal year 1991. Because of the high technical and programmatic risk in the FEL program, the Air Force will continue to conduct a parallel directed energy technology development program designed to address critical technology issues, project costs associated with the effort, and prepare alternative concepts for a fiscal year 1991 directed energy system selection.

Up until now, I've discussed our ASAT acquisition program as it applies to future development efforts. To meet the urgent and long-

standing requirement of developing at least an initial ASAT deterrent capability as quickly as possible, former Secretary Carlucci determined that for less than 20 million dollars, the high energy ground based laser research and development facility located at White Sands, New Mexico referred to as the Mid-Infrared Advanced Chemical Laser or MIRACL, and its associated beam director called the Sealite Beam Director, could be upgraded by calendar year 1990 to potentially provide an interim, very limited and very near term ASAT deterrent capability.

The MIRACL and Sealite Beam Director system is a technology development and risk reduction program which supports several ground and space based laser research programs, such as tactical testing against low flying target drones for the Navy, and lethality, tracking and atmospheric propagation experiments for SDI's ballistic missile defense studies.

This system is the Nation's only integrated high energy laser system, and although only a research and development facility, the knowledge gained from ASAT-related modifications of the Sealite Beam Director upgrade may enable us to counter some key Soviet satellites that threaten U.S. and Allied terrestrial forces, particularly naval forces.

We could get into the details of that perhaps later in a closed session.

At the same time, the Department can gain useful information on ground based laser ASAT technology issues until other ground based laser ASAT systems with greater growth potential but with greater developmental risks can be procured.

In conclusion, the ASAT program we have presented in the President's budget provides a coherent, balanced program to meet our most urgent space control need. It can provide systems that protect our land and sea assets from Soviet weapons that rely on targeting from low altitude Soviet satellites and it can help to deter Soviet aggressiveness in space and on the earth.

It addresses two important East-West asymetries.

The one General Piotrowski referred to is between a maritime power and the land based power. Congressman Dickinson mentioned the unified DOD position on this issue.

I would like to introduce some of the people behind me now.

We have General Don Pihler from the Army R & D Office, who is responsible within the Army Secretariat for ASAT. General Tom Moorman is from the Air Force. We have Admiral Ken Malley who is the manager from the Navy's aspect, and we have General Morgan Jellet, who has been designated as the Army's program manager.

I think that is an indication of the jointness with which this problem is being approached by the DOD.

I would like to address one concern that I know of Mr. Chairman. We are in receipt of your letter of 22 February that addresses the MIRACL. We received your letter about a week after the reprogramming action had gone into effect.

Our view at the time was that it was well within our purvue to reprogram those funds and it was done through the OSD comptroller's office.

The other point we made there is that we are not developing an operational capability with the MIRACL upgrade as your letter suggested. We are talking about a research and development facility and upgrading it so it has contingent ASAT capabilities as a research and development facility, and will continue to be used that way for valuable testing programs.

We had quite a bit of support from various Members of the Congress. It will be operated by a military organization and employed routinely in that manner.

Mr. Chairman, this concludes our prepared remarks. We would be happy to respond to any questions that you may have.

Mr. DELLUMS. Thank you. The chair would indicate that he recognizes that the subject matter before us today is such that full and complete answers to some of the questions may not be able to be obtained because of the classified nature of certain information.

I have indicated to the General as well as the ranking minority Member that it is the chair's desire to have this hearing today in open session. I think there is a clear justification for an open session to at least draw out what it is you are asking for, what you want to accomplish, to look at some of the assumptions and policy implications in open session.

The chair will indicate to my colleagues that we will schedule a closed meeting where we can get into classified information and go behind some of the general responses that will be made today.

Before we move to other Members, the chair would like to begin. Each of you have touched upon some of the areas my opening statement questions raised, but to begin to establish a record and focus everyone's attention, I would like to go back to these questions.

First of all, how much money is being requested in fiscal year 1990 and how will this money be used?

Mr. KENDALL. The funds requested in fiscal year 1990 are in three or four different locations. In the case of directed energy portion of the program, there is $15 million in 1990 allocated to the Army which will be used to provide ASAT-related requirements for the SDI free electronic laser program.

We are leveraging off a $275 million planned investment in that program in 1990. In the kinetic energy case there is $95 million requested again to the Navy that is budgeted in the Navy and we are addressing that as we go through the budget today.

The final decision on who will have that money has not been made. Currently budgeted to the Navy is $95 million in fiscal year 1990 for kinetic energy ASAT development.

That leverages out a sizable amount in 1991. The other element is $16 million which is in the Air Force to upgrade the space/$C^3$ network.

Finally, there is $38 million contained in the ground based laser technology effort within the Air Force.

Mr. DELLUMS. The second broad question is, what is the purpose of your ASAT program? Where are you trying to go with this? You canceled the F-15. Is this a brand new start? Do you have a set of assumptions on which you are operating? What is the purpose of ASAT and where are you trying to go?

Mr. KENDALL. We are working toward fielding an operational ASAT capability directed and kinetic energy by the mid-1990s. We are not restarting the F-15 program. We are trying to take advantage of the sizable investment in SDI technologies to the extent that we can to field a new start on the kinetic energy side and develop the free electron laser or another suitable one if necessary on the directed energy side.

Mr. DELLUMS. General, in your opening statement you suggested that it would be extremely difficult to replace our satellites for some time, you mentioned a matter of weeks or even months. The obvious question that begs to be asked is how will our satellites be more secure after the development of ASAT than they are now? How does ASAT address the vulnerability of our satellites?

General PIOTROWSKI. In the first instance, Mr. Chairman, the ASAT we envision would have the ability to defeat the Soviet orbital ASAT so we could shoot down the threat to our satellites. That is how I would envision it protecting our satellites in the first instance.

Second, it holds at risk Soviet satellites, so one would hope that our strategy of deterrence that we use so effectively on terrestrial forces would also apply in space.

More importantly, the availability of an ASAT that was effective in targeting their earth satellites would deter them from aggression in the first instance because they would have to recognize that if they started a conflict, they could lose very quickly those targeting assets that they use to threaten our soldiers, sailors and airmen.

So I think in all those ways, but more importantly, I think it kills their orbital ASAT which is one of the technologies they have, and also threatens destruction of the things they hold dear in a conflict.

Mr. DELLUMS. If I am correct in my opening assertion that we are technologically superior to the Soviet Union in terms of the satellite capability and we are on an increasing basis of integrating our satellite systems, becoming satellite dependent, developing the utilization of the satellites for conventional, tactical and strategic planning, increasingly using satellites for intelligence gathering capability, as well as economic forecasts and weather forecasts, and using satellites that are interdependent upon other satellites in order to function, it seems reasonable that a lay person would conclude that if we pursue ASAT technology, we would have more to lose than the Soviet Union.

Why not let sleeping dogs lie? Why are we pursuing an aggressive ASAT program that may turn out to be to our deterrence because we are more dependent on it than the Soviet Union?

Therefore, it might not be in our best interests. How do you respond to that?

General PIOTROWSKI. Yes, sir. You made three points, two of which I fully agree with, and the third I would discuss.

The first is that we in the United States are continuing to become increasingly more reliant and dependent on satellites.

The second point which you made first, is that we are technologically superior to the Soviets. Then you say maybe it is best to let sleeping dogs lie.

What grew from that, and it is public knowledge, is the fact that the Soviets are becoming increasingly more reliant on satellites than we are, I mentioned the Falklands conflict in 1982.

The Soviets at that time had approximately 100 satellites in space. They leaped up to about 125 during the Falklands conflict when they made those 29 launches and then they declined back to 100. Of course, part of our responsibility is to keep track of the Soviet's space ability for battle. Today I can tell you that they have more than doubled, they have more than 200 satellites in space.

I could point out in closed session how much more capable some of their systems are today, how much more reliant I believe they are, and what systems they have and what capability they have that we don't have in our space arsenal.

One example is a direct targeting system like radar reconnaissance satellite. So while your statement is certainly correct and I agree with it, the Soviets are far more reliant and moving at a sharper slope than we are on space systems.

So I believe it is to our advantage to have the capability to destroy those space craft and hold at risk those space craft to prevent aggression in the first instance.

Mr. DELLUMS. In a San Francisco Chronicle article, February 6, Associate Director of the Lawrence Livermore Lab, Michael May said, "My own view is that ASATs are not in our security interest."

Does the Air Force believe that Dr. May is mistaken in his assertion?

General PIOTROWSKI. I don't know on what basis the learned gentleman made that statement. As I say, there is clear and unequivocal evidence that the Soviets are rapidly ramping up not only in the numbers of satellites but in the capability those satellites bring to bear in terms of conventional war and the threat they bring to our systems.

They have not only the co-orbital ASAT but other technologies. For example, one of their prize capabilities is radio electronic combat, the ability to defeat things through electronic jamming.

It is clear that has very, very great capability against many of our systems. They are developing at this time two advanced ABM systems, one of which clearly has enormous potential as a direct ascent weapon against our satellites. What we have is a tremendous asymmetry in our ability to operate in space.

The Soviets have this very robust infrastructure to get into space quickly with a large number of systems and to defeat ours. I sincerely believe we need to redress that, not only to threaten the Soviet systems but improve our responsiveness.

I don't know what information the gentleman uses to make that statement, but I disagree unequivocally.

Mr. DELLUMS. In 1987 President Bush's present national security advisor, Mr. Scowcroft, co-authored an article entitled Anti-Satellite Weapons and U.S. Military Space Policy. It is interesting in that article he wrote, and I quote, "In a sense, satellites are becoming the eyes and ears of each side's defense establishment. They are critical for effective command and control. For early warning of attack and military intelligence and arms control verification. Denial or interference with these missions would be a highly provocative act."

Does the Air Force believe Mr. Scowcroft is wrong in making this assessment?

General PIOTROWSKI. Mr. Scowcroft, I think, was careful in commenting on command, control and warning. It is clear that the geosynchronous satellites, or the highly elliptical satellites in the Soviets' case, that we use for communication and warning are geosynchronous, for example, and their highly elliptical one would not be targets in an ASAT exchange.

We are looking at the low earth orbiting systems that directly threaten our forces as the primary ASAT target. So in principle I would agree that it would be a highly provocative act if we attack their warning systems that would warn them against an ICBM strike or in the same context I would agree that if they tried to attack our infrared system in geosynchronous orbit that warn us of their attack, we would look on that maybe as a precursor for a strike.

We are talking about a low earth orbiting satellite that tells us about the disposition of forces and the activity of forces. Recently Admiral Hardesty of the Pacific Command and Admiral Kelso of the Atlantic Command spoke of ASAT as their highest priority to protect their forces at sea.

Yesterday Secretary Taft and Admiral Crowe spoke about ASAT as being their highest priority to protect forces.

Mr. KENDALL. If I could address that, I know Mike May very well. I have a great deal of respect for the gentleman. I think he has made an error in logic that many make discussing ASAT.

We focus on space only. You have to broaden your view to the earth. The question is not should we trade our satellites for theirs or what is our relative position in terms of satellites? The question is should we trade our satellites versus us having the sea lines of communication. For the satellites there are back-up ways to do business. You can replenish, but we have to keep the sea lines of communication.

The Soviet satellites that threaten those lines of communication are critical to us.

Mr. DELLUMS. General, in making your response to my first question regarding General Scowcroft's assertion, I think you have testified but let me challenge you further because in that very same article I find it also interesting that General Scowcroft writes "The United States therefore has a major security interest in preventing the commonplace presence of advanced ASAT threat to satellites at altitudes above low earth orbit."

So you agree with that assessment or disagree with it?

General PIOTROWSKI. My position on that statement, Mr. Chairman, is that while there are, I think, strong arguments in principle that it would be nice to negotiate away that capability or prevent that capability from existing, I believe it is absolutely unverifiable, for example, the capability to be an ASAT exists in every satellite. One would have to inspect every one of their payloads and they would have to inspect every one of our payloads. Any one of their antiballistic missile system does have a significant ASAT role.

What we are arguing about concerns its capability. How high can it go and what systems can it reach? Directed energy systems

which the Soviets are moving ahead on at an enormously threatening pace are clearly threatening to satellites at all altitudes.

I think it is an unverifiable situation that while one may argue the philosophical approach to that, it is not achievable.

Mr. DELLUMS. While you agree that it could be provocative to challenge these geosynchronous satellites in geosynchronous orbit, as I gather from staff, that in March of last year you testified before this subcommittee when Mr. Aspin was the chairman and in that testimony you stated that the U.S. should develop ASATS that can, and I quote from your testimony, "Engage enemy aircraft at all altitudes."

Does the Air Force believe Mr. Scowcroft is wrong about geosynchronous orbits? Have you changed your mind? Then you said you should threaten at every level, if you threaten by geosynchronous then you are by your own testimony threatening command control and communications which can be very destabilizing, and there is no ability to communicate at that point.

General PIOTROWSKI. There is a difference between what I said and what is being interpreted. I said we should have it if it is decided at the highest levels that we should have ASAT. I am in favor of having the capability. The judgment decision on when we should use that capability and what we should use it against is different.

Mr. DELLUMS. If you have the capacity to threaten, doesn't the other side have to take in to account your capacity to threaten? When we sit here in these meetings a great deal of the rationale for a lot of what we do is that the Soviets have the capacity to do it. If the shoe were on the other foot, we would be saying they have the capacity to challenge, therefore, we are threatened. Therefore, we have to plan on the potential worst case scenario.

So why don't we put the shoe back on our own foot? If we have the capacity to challenge and threaten them, do they have to then plan that potentially then you could use that which then requires an escalation in both capabilities?

General PIOTROWSKI. I would certainly agree that that is the situation we are in today, that the Soviets have the capability to destroy our satellites and we have no means of responding other than what I think would never be taken, and that is horizontal escalation, attacks against the Soviet homeland and infrastructure.

Mr. DELLUMS. Have the Joint Chiefs of Staff, to your knowledge, issued a requirement to have ASAT have the capability to reach geosynchronous orbits?

General PIOTROWSKI. I would have to answer that in closed session.

Mr. KENDALL. If I could speak here, the program we have in the budget does not include the capability to go to high altitudes.

The second point is that indeed the initial act of attacking the high altitude $C^3$ satellites would be destabilizing. That is more likely to occur after initial exchange has taken place. By that time it is hardly a relevant question as far as stability is concerned.

Mr. DELLUMS. I appreciate your response.

I think you would agree with me that, since this is the R&D Subcommittee, we have the responsibility here to think long-term. I assume you are thinking long-term, you are looking into the

future. We have the responsibility to determine where this program is going to go.

Mr. KENDALL. My response is that this program is not intended to go to geosync.

Mr. DELLUMS. If the Soviets have their satellites go to all altitudes, would this be of concern to the Air Force?

General PIOTROWSKI. It would be of concern in that our medium altitude satellites are threatened, speaking about above the Van Allen Belt. So it would concern me as I am concerned today. Again, I could present evidence in closed session.

What we see is a very robust research program on the part of the Soviets to improve their capability in all areas that would lead to anti-satellite capability.

Mr. DELLUMS. A final question. In 1984, then Air Force Chief of Staff General Charles Gabriel testified to Congress, "I would like to be able to agree with the Soviets that we not have any ASAT, if we could verify it properly."

Do you feel that General Gabriel was misquoted when he said both the United States and the Soviets would be better off if neither had ASAT?

General PIOTROWSKI. Certainly. When General Gabriel testified, he was basing it on the capability that the Soviets had extant at that time. So much has changed that I believe if General Gabriel were making that statement today, it would be otherwise. He would be very much in support of an anti-satellite capability. In 1984 that statement may have been relevant, but in 1989 I strongly disagree.

Mr. DELLUMS. I thank you. I hope some of these questions will elicit questions from my colleagues.

The Chair yields to the gentleman from Alabama, Mr. Dickinson, for such time as he may consume.

Mr. DICKINSON. Mr. Chairman, you indicated you do not desire to go into executive session this morning. We have enough Members here to authorize executive session at any such time that you may want to go into it.

Mr. DELLUMS. If the gentleman would yield, the Chair would be guided by the wisdom of the committee. The Chair would assume that some Members would at some time want to ask questions in classified session.

Mr. DICKINSON. I will move that the subcommittee be authorized to go into executive session for today and 5 additional days of hearings for the purpose of receiving information affecting national security.

Mr. BAYER. Mr. Dellums.

Mr. DELLUMS. Aye.

Mr. BAYER. Mr. Dickinson.

Mr. DICKINSON. Aye.

Mr. BAYER. Mr. McCurdy.

[No response]

Mr. BAYER. Mr. Davis.

[No response]

Mr. BAYER. Mr. Foglietta.

Mr. FOGLIETTA. Aye.

Mr. BAYER. Mr. Stump.

[No response]
Mr. BAYER. Mr. Hertel.
[No response]
Mr. BAYER. Mr. Hunter.
Mr. HUNTER. Aye.
Mr. BAYER. Mr. Darden.
Mr. DARDEN. Aye.
Mr. BAYER. Mr. Weldon.
Mr. WELDON. Aye.
Mr. BAYER. Mr. Hochbrueckner.
Mr. HOCHBRUECKNER. Aye.
Mr. BAYER. Mr. Kyl.
Mr. KYL. Aye.
Mr. BAYER. Mr. Pickett.
Mr. PICKETT. Aye.
Mr. BAYER. Mr. Dornan.
[No response]
Mr. BAYER. Mr. McNulty.
[No response]
Mr. BAYER. Mr. Bennett.
Mr. BENNETT. Aye.
Mr. BAYER. Ms. Schroeder.
[No response]
Mr. BAYER. Ms. Byron.
Ms. BYRON. Aye.

Mr. DELLUMS. The Chair would like to thank the gentleman for that. If time permits, we may go into closed session. Thank you.

Mr. Dickinson.

Mr. DICKINSON. Let me thank you for appearing. It is good to see a unified voice speaking for an ASAT capability.

For the past 4 or 5 years I have been the principal defender of the capability and the concept. I have had very little support from the services, except from the Air Force, because they wanted the F-15. Zero support came from the Navy. They didn't do a darn thing. Now they have seen the wisdom of protecting their assets at sea.

It is sort of lonely up here if you are the only one fighting the fight and they are not even supporting the administration's position. If you think I am wrong, just go back and read the record.

Anyway, welcome aboard. We are going to try to help you. I think as the facts develop and we learn more and more about it, we will have less and less problem on the floor, even though there is a cadre totally dedicated to blinding the United States and keeping us from having the capability, but I think the good guys are growing and we are going to be successful for the first time in 3 years.

Let me make sure I understand what we are talking about—that we all understand.

There are basically three heights of satellites, right?

General PIOTROWSKI. That is basically correct.

Mr. DICKINSON. So we have the low earth orbit satellite, which is the most vulnerable to ASAT capabilities, and then we have the high elliptical or middle band, which is next vulnerable, and then we have the high, 2,200?

General PIOTROWSKI. Twenty-two thousand miles.

Mr. DICKINSON. Then that is geosynchronous, which is very difficult, but not impossible, to reach with an ASAT capability.

When we are talking about the capabilities we are building, it is important to explain to us what we are building against and what the Soviets are building against.

I know you have touched on this in part and the answer has already been elicited by Mr. Dellums. If we are talking about the geosynchronous orbit of 22,000 miles, we would know in advance if we were attempting to blind it. There are much more rapid ways of attacking low earth satellites, with a missile, perhaps a ground-based interceptor, lasers or whatever.

Am I right so far?

General PIOTROWSKI. Yes, sir.

Mr. DICKINSON. Correct me if I am wrong.

General PIOTROWSKI. No, sir, you are absolutely correct.

Mr. DICKINSON. At the present time we are proceeding with the R&D development. We have abandoned the F-15 missile launched concept and we are proceeding down more or less four parallel roads in our capabilities in research and development.

Is that right?

General PIOTROWSKI. Yes, sir.

Mr. DICKINSON. The MIRACL is the closest in hand to give us some capability, right?

General PIOTROWSKI. Yes, sir.

Mr. DICKINSON. Would we have to go into closed session for you to discuss the four types which are presently in research and development so that we can understand the difference of what they are intended to do?

Mr. KENDALL. I can address the four types of laser systems.

Mr. DICKINSON. So you have the laser system with kinetic energy. Is that one?

Mr. KENDALL. Yes.

Mr. DICKINSON. Can you give us the four systems and what they will do, so we will understand in context what we are talking about?

Mr. KENDALL. The kinetic energy system is basically a surface-launched, rocket-carrying homing rocket, an optical homing system. It would be new technologies that have been developed since the MV program was started over 10 years ago. It would rely on the technologies coming out of SDI. There are a number of concepts being pursued competitively within SDI for a ground-based interceptor.

As to the lasers, we conducted a study of several laser alternatives last year and it was provided to the Congress last summer. There is a significant difference in those systems in terms of risk, costs and when they would be available.

The one most readily available, in terms of technical risk at least, is the MIRACL, Mid-Infrared Advanced Chemical Laser. We looked at an upgrade to that during the study last year, a substantial upgrade, much more than we are talking about now. We decided that would take roughly 4 years and cost about a quarter of a billion dollars.

We did adopt the near-term, very inexpensive, very quick and less capable option of MIRACL at Mr. Carlucci's direction. That

system has a limitation in that it has less growth potential than the other candidates. That is a detailed technical issue. It gets into the wave length of a laser and the technologies associated with it.

Working down the line, if you will, the next two, oxygen iodine and free-electron laser, were the next candidates. They both had more risk than the chemical system because they are a shorter wave length. There is a major program, in the order of $2 billion over the 5-year defense plan, for the free-electron laser. That is being developed for SDI purposes. When we looked at the various candidates, we could not ignore that. That was a funded requirement for a different purpose. We made the decision to leverage off that.

The FEL is fairly high risk in terms of the physics of the device. We felt the funding and the schedule of SDI could be meshed into an ASAT.

Oxygen iodine, which is a similar wave length, has some risks but also less growth potential.

Mr. DICKINSON. First, of the four, they would be designed to go against what?

Mr. KENDALL. All the designs we looked at were for low earth orbit. It is a factor of 400 in terms of laser capability to go from low earth orbit to geosynchromous. It is a challenging task just to build the low earth system and it is a substantial growth from there to geosynchronous.

Mr. DICKINSON. If we should have a shooting war with the Soviets, the most critical thing for them to deny us and us to deny them is the low earth orbit, right?

Mr. KENDALL. In terms of conventional warfare, yes.

Mr. DICKINSON. So this is the capability we are working on now. We don't know where the R&D might eventually go, but we are not working on it for anything other than low earth orbit, right?

Mr. KENDALL. We are focusing on that because it is a hopefully achievable target for the low 1990s.

Mr. DICKINSON. This one is a rocket that is fired and expended and it is gone. The other ground-based, if it were operational, would be dispersed at different places around the earth's surface, I assume, or perhaps even on shipboard?

Mr. KENDALL. The basing for the rocket kinetic energy system has not been decided yet. It depends on how quickly we need to engage targets and how much energy we put into the system. There is a possible ground-based and sea-based version. We have not completed our study of that yet.

Mr. DICKINSON. One of the points you brought out is that if we have a capability of taking out their satellites and they have the same capability of taking ours out, if they were all blinded initially they have a ready response that they can re-orbit and we do not have that capability, right?

Mr. KENDALL. Yes.

Mr. DICKINSON. In an initial exchange, if we were blinded and they were blinded, it would be months before we could replace ours and days before they could put their satellites back up, right?

General PIOTROWSKI. You are correct, Congressman.

Mr. DICKINSON. We need to have a more capable system than the Soviets with the fire capability, and that is where the laser has the

greatest potential. We need to continue to take out their replenishment satellites as well as the low earth satellites.

Mr. DELLUMS. Will you yield?

Mr. DICKINSON. Yes.

Mr. DELLUMS. In order to embellish on your answer so that Members can understand, I think it is appropriate to tell the committee why it takes you longer.

As I understand it, it is because our technology is superior, our payload is heavier. They have lighter, less expensive and less sophisticated satellites they can put up quickly, but it takes us longer because we have heavy payload satellites.

If that is not correct, tell us why it takes us longer than it takes them.

General PIOTROWSKI. Historically we developed in two directions after 1965. Both the Soviet Union and the United States conducted frequent launches, probably in the neighborhood of 50 a year. At that time the technology that you speak of became available to build long-life satellites, ones that lasted 7 to 10 years and provided fine granularity and information this Nation thought necessary.

In the past few years they have averaged 100 launches a year and we have dropped down to 10 to 15, even when we had the capability to launch as much as we wanted. That, I believe, was generated on the premise that our satellites were not threatened.

The Soviets, I believe, had the goal of having a war fighting space capability, taking control of space, and being dominant in space. Because of the technology we did not see the reason to do so. Especially now after the Challenger tragedy, we don't have the launch pads, the infrastructure, the war reserve stockpiles to launch quickly. The Soviets, on the other hand, have developed that from day one. So we have great asymmetry in our space infrastructure. That is basically the reason.

We did not see the need years ago to be able to launch on demand and make a satellite operational very quickly. On the other hand, the Soviets do it with great rapidity.

Mr. DELLUMS. Is it true also that it is more expensive for us to send our satellites up because they are more sophisticated and because they are heavier payloads, with greater thrust, and it is more expensive to put it up?

That is not to take away from the other points you have made, but another point is that ours is more expensive. It costs more money to put that up there, isn't that true?

General PIOTROWSKI. I am not qualified to speak on how much Soviet satellites cost.

Mr. DELLUMS. Our satellites.

General PIOTROWSKI. I don't have the basis of comparison.

It was really more of an attitude developed historically. There is no reason why this Nation cannot develop it. It would require an investment and change in focus on the way we do business. We have the lift capacity. We have not developed the multiple preparation. We call them vertical assembly buildings. We have one essentially supporting two launch pads.

The Soviets told former Secretary of the Air Force Aldridge, when he visited there, "oh, we develop two satellites at a time, wheel them both out to launch pads and then choose which one we

like best." Well, that strategy also gives them the tremendous capability to launch another one immediately. They have chosen to stock with liquid propellants, which means they have lightweight cans. It is not an explosive device that they have to handle carefully while they check the satellite out. They do all this horizontally on a launcher, which is an erector. They do this in a few hours and then launch. On the other hand, we go through a much more rigorous procedure to check out our systems.

So the philosophy and strategy are different, which gives them a significant wartime capability.

Mr. DELLUMS. I thank the gentleman. It is fascinating.

From this exchange one might conclude that one deterrent to ASAT is your ability to rapidly put a replacement out there. If the other side knew you could replace your satellite quickly, that would be a deterrent.

General PIOTROWSKI. We are clearly discussing ASAT, but if we were discussing the overall space structure I would argue that we need to improve survivability of satellites, we need to put more on orbit spares, which the Soviets do in large numbers, and we need to improve our infrastructure, as you suggested—that is an excellent point—and we need to have ASAT as well.

Mr. FOGLIETTA. Would you yield for one question?

Mr. DICKINSON. Of course.

Mr. FOGLIETTA. Talking about the survivability of the satellites, from my information the Soviets have launched approximately 100 satellites per year and we have been launching less than 10 per year. Yet my information also is that we have the same number of satellites in orbit as they do.

Is that because ours are of better quality and have more survivability and stay in orbit longer, or what is the reason?

General PIOTROWSKI. The information you give is very correct. The numbers are not exactly the same. The Soviets have over 200, we have a little over 150.

Mr. FOGLIETTA. But we put 10 percent of what they put in orbit. What is our advantage over them?

General PIOTROWSKI. Our technology, the reliability, redundancy that is built into satellites, which I think we can all take great national pride in, and our strategy has been to launch longer-life satellites in the first instance.

They, on the other hand, while their numbers of satellites in space has been increasing—well, let me take another crack at that.

Mr. DICKINSON. We are talking about operational satellites here?

General PIOTROWSKI. Yes, sir, operational system.

The Soviets have continued to stay with short-term satellites, ones that last months instead of years. That allows them to have the hot production base of boosters. Technology is why we are where we are, and technology is why they are where they are.

A point I would make is that they have launched the same numbers of satellites over the last 10 years: this year 100, last year 98, the year before 96. But the number of satellites they have in orbit has doubled, which should tell us their satellites are becoming significantly longer-lifed and they are closing the technology gap.

Mr. FOGLIETTA. Thank you.

Mr. DICKINSON. Can you tell us what we know of the Soviet capability today? We have seen them demonstrate a full orbit intercept of an object in space we have also seen a partial orbit intercept of an object in space which we have never done, which we denied ourselves the right to do with the F-15.

It is my understanding that the Soviets have an operational deployed ASAT system today. Is that right? If so, do they have more than one operational system?

General PIOTROWSKI. Sir, I am absolutely convinced, and I think I could say in closed session that the Soviets have an operational anti-satellite system on alert today; and that that system is well-tested in the first instance, and that there is clear evidence that that keeps that system exercised. I will give you an example.

The SL-11 boosters, which launches the electronic ocean reconnaissance satellite, launches the ASAT weapon. They have launched that booster with other payloads 27 times, which means the launch crews. The system is exercised on a regular basis.

It is the booster that is the brains to putting a co-orbital satellite in plane with its victim. They also exercise the other parts of that regularly. For example, every Progress docking with the MIR, they must use the same algorithms and technology to bring those together as they would with their satellite together with the victim satellite.

I could go in to closed session with more information, but I am absolutely convinced that that system is very robust, very capable and on alert.

I would also suggest to you that they have tested a number of times, and we know that it is more than 50 percent capable of destroying a victim, which is better than any system I have gone to combat with.

Mr. DICKINSON. You have a big screen here. Is that for the closed briefing?

General PIOTROWSKI. It was for the classified portion.

Mr. DICKINSON. Thank you.

Mr. DELLUMS. The Chair recognizes the gentleman from Florida, Mr. Bennett, for such time as he may consume.

Mr. BENNETT. Several things have been said today that I have never heard before. You said you did not feel like it would be verifiable to have an agreement that neither of us have ASAT in space. Is that a true statement?

General PIOTROWSKI. Yes, sir, it is.

Mr. BENNETT. I am wondering, with the pictures that you paint of both of us having ASAT and satellites, and we are much more dependent on satellites than are they, I am wondering why we are pursuing a course to become so dependent.

It seems to me the major thrust of our program should be to get a substitute for satellites, such as ELF or something like that.

General PIOTROWSKI. I must have misspoken. I said, while we are dependent on space and that dependency increases as we develop more capability, I strongly believe the Soviets are increasingly more dependent on space at a much greater rate than we are.

Mr. BENNETT. That does not contradict what I said. I said we are more dependent on satellites than they. You said they are becoming increasingly more dependent.

General PIOTROWSKI. I have no information that we are more dependent on space than the Soviets.

Mr. BENNETT. I have often heard it said.

General PIOTROWSKI. I have no evidence that would suggest that we are more dependent on space than they. Other than that, our technology is better.

Mr. BENNETT. How about our Navy? Isn't our Navy pretty dependent on space at the present time?

General PIOTROWSKI. Yes, sir, and so is theirs. In fact, their Navy uses tactical systems that our Navy doesn't have.

Mr. BENNETT. You said the current program is not intended to be able to hit satellites in geosynchronous orbit. Ted Postal of Stanford wrote me last year that it would not be hard to hit them in geosynchronous orbit if we added a third stage to the launch.

Mr. KENDALL. There are other trades. We could build a larger rocket, but that is not our intent at this time.

Mr. BENNETT. It strikes me the picture you are painting of outer space is not a hopeful picture. It looks to me like we both must rush forward on a lot of things that are helpful and destructive, depending on whose side you are, and at the end, it will be just destructive.

In combat, I think you can feel if just because they are badly hurt, if they would do the same thing, I wouldn't rely on that. If I were in combat, I would do whatever I could to hurt the enemy.

It seems to me we have a challenge to do whatever you suggested, so we wouldn't be so dependent, so much tied up in space.

Mr. KENDALL. Dependency is a word that sounds strong when used in isolation. How strong a dependency we have on space I am not qualified to say. We are, however, extremely dependent on our ability to support and resupply our allies overseas.

Mr. BENNETT. If you have an undependable electric system and your office was all computerized, and you did not have any manual typewriters, you would not get many letters out. You would win the battle of letters if you had manual typewriters.

It seems to me we are inventing ourselves into situations with regard to war that are not winnable. We should concentrate on things that are much more likely to win wars.

Mr. KENDALL. I would agree that we do need to have more resilient space capability and back-ups to those capabilities. I would not, just as a substitute for doing that deny ourselves an ASAT, in, I think, the forlorn hope that the Soviets would do the same thing as well.

Mr. BENNETT. You said two things categorically today that I have never heard substantial people say before. One was that you feel like they have a very good system. That has been denied on the floor of the House numerous times by people of some reputation.

You seem to think they have a very good system in place, and you feel like it is not verifiable that they would not continue that. Those are two elements which certainly are moving in the direction of persuading me against the satellites.

I think we may be inventing ourselves into the type of war that is not likely to occur, and in which we don't have much of an advantage. I would like to see us in a position where we would be more gutsy on how we won wars.

General PIOTROWSKI. I can substantiate the remarks in closed session as to why I believe the Soviets have a very capable system.

Mr. BENNETT. Thank you.

Mr. KENDALL. The Soviets have a system that meets their requirements. You can argue about quality, but the Soviets have a system that meets the job. They have other capabilities, as General Piotrowski pointed out, besides the ASAT. There are a number of other systems, ground-based lasers, for example, which also have ASAT capability.

Mr. BENNETT. One more question. Isn't it true that if ASAT works, then SDI cannot?

Mr. KENDALL. No. ASAT is recognized as an important threat to SDI. The space-based elements of SDI are stressed by ASAT threat in terms of hard back and other things. It is a well-recognized threat. It is acknowledged in the program.

Mr. DELLUMS. Mr. Pickett is recognized for such time as he may consume.

Mr. PICKETT. Thank you, Mr. Chairman.

The figures that you gave us a moment ago, the budget of $164 million for this program, can you tell us what the ultimate cost of the program is going to be through the development capability?

Mr. KENDALL. It is difficult to do that without more certainty on the fate of SDI, because we are trying to leverage off SDI. Let me try to give you an answer as best we can, for the record.

If possible, I would like to defer that answer until we complete our strategic review, which will better define a number of things, including SDI.

Mr. PICKETT. If you could get that information by year, if possible. Second, when do you at this point plan for this development program to be completed?

Mr. KENDALL. We would expect to see the kinetic and directed energy systems both fielded by the late nineties.

Mr. PICKETT. What follow-on programs, if any, do you anticipate in this area?

Mr. KENDALL. There is a continuing technology program in laser technology. At the present time, we have not contemplated a follow-on program in terms of weapons development. We have other requirement programs, but we have not had the ability to address them. Given the difficulty we have had in getting the ASAT program, I think we would be glad to get them by the late nineties.

Mr. DICKINSON. Will the gentleman yield?

Mr. PICKETT. Yes.

Mr. DICKINSON. What would be the earliest you would expect to test against something, even a point in space? What do you envision testing?

Mr. KENDALL. It is critical to the success of any development program that testing be done. We have a statutory requirement to do live firing tests in any new weapons systems. We will do it when it fits into the program. That could occur in the case of the MIRACL upgrade in 1990.

In other systems, it would not occur until 1991 or possibly 1992. That depends on the budget and the details of the program. The longer-term laser program would be mid to late 1990s.

Mr. FOGLIETTA. [presiding] Thank you. I not only have assumed the Chair, but I am next in line for the questions.

You described the Soviet ASAT program as, I think you used the word, "sophisticated."

General PIOTROWSKI. I don't mean to imply that the co-orbital ASAT is sophisticated. It is certainly capable, but they have a number of things that I could talk about in closed session that do fall into the category of sophisticated.

Mr. FOGLIETTA. The thing that upsets me at this point is that according to the Congressional Research Service brief, January 12, 1989. They say that the Soviets have one operational ASAT. It has not been tested since 1982.

Before that, it failed in 11 of 20 tests, and the last six tests were all failures. Second, the publication, "Inside the Pentagon" of February 17, 1989, again paraphrasing, says that a recent CIA report claims that the Soviets have a negligible ASAT capability and have made little if any progress since 1985.

How do you put those things together, reliable sources, with what we have heard today?

General PIOTROWSKI. Unfortunately, the information that you read is approximately correct and exactly wrong. What they have done is that they have mixed two capabilities together. All I can tell you is that I could speak to that precisely in closed testimony.

What the people that have put that information together have essentially said, has lumped two different things together and then came out with the answer. The truth was that one was an abysmal failure, and the other was a good success.

When you lump them together, you get a modest failure. I can speak to that in closed session.

Mr. KENDALL. The latter series of tests was a different design and different technology. It is not what they have fielded.

Mr. FOGLIETTA. Yesterday, we had testimony from General Monahan about the first and second phases of the SDI program. Where does the ASAT program start and end, and where does SDI start and end, and how do they clash or blend with one another?

It seems to me we are hearing almost a repetition of things we heard yesterday in another program. Is this a duplication of money and effort?

Mr. KENDALL. No. The attempt was to leverage as much as possible off of the SDI program. They have different policy programs. SDI is a policy program for future decisions. The ASAT program is one we intend to take to deployment. We want to capitalize to the fullest extent possible on the work being done on SDI, at least through full-scale development.

A lot depends on how SDI proceeds and when we make critical decisions about SDI. We are being careful not to duplicate our effort and not to pay twice for the same capability.

Mr. FOGLIETTA. Would not the SDI program include an ASAT program?

Mr. KENDALL. There are some inherent ASAT capabilities in SDI components once they are fielded. The problem is when that decision will be made to field it. We know we have an urgent requirement to go ahead and field an ASAT capability.

Mr. FOGLIETTA. It was pretty much agreed that as we proceed with the SDI program, we are going to come to a situation where we will be in violation of the ABM Treaty, if we continue with it. Will this not also apply to your program?

Mr. KENDALL. No. The ASAT program will be included. We have decided that the review will be conducted before Milestone One next winter. We will not do anything in violation of that treaty.

Mr. FOGLIETTA. Thank you.

Mr. Darden.

Mr. DARDEN. Thank you, Mr. Chairman.

Gentlemen, I appreciate your being with us today. Like the ranking minority member, I wanted to commend you on what I think is an outstanding display of unity. I think it is evidenced by the questions asked this morning that this is a topic on which a number of conscientious members will disagree.

It will not end here. It will go to a floor vote in the House. To look at how controversial this has been, it is one in which only a few votes separate the prevailing party from the party that fails to achieve its goal.

So, I suggest that in order to be successful, this very outstanding display of unity must continue from now throughout the entire process. I am particularly impressed with the pronouncements of the former Secretary of Defense Carlucci about the necessity of this program.

I suggest to you that if you are to succeed in convincing the Congress of the need for an ASAT, you remain on course with the emphasis for the critical need of an ASAT capability, keeping in mind his statement that this is a potential Achilles heel in our defense posture, which must be corrected.

I have only one question this morning. Most of my questions will come in the session later on, in the classified session, Mr. Chairman.

It is my understanding from what you said and what has been written and the questions asked by my colleagues that we have number of technologies also in place which merely need to be integrated in order to achieve an ASAT capability, and that some are under the SDI.

Should the technologies be developed in a capable system to correct the system of which Mr. Carlucci complains? Is that substantially correct?

Mr. KENDALL. I would agree completely with Secretary Carlucci's comment that it is our most serious deficiency. We are pursuing that in that light.

Mr. DARDEN. About the technologies, is that correct?

Mr. KENDALL. We think that the technologies being developed are applicable and can be utilized to give us an ASAT capability. In the technology we think the risk is moderate. We have demonstrated the reentry vehicle program, the ability to engage targets in space.

It is a question of going out and doing a job. As a result of leverage on SDI, we believe it can be done quickly relative to other development programs.

Mr. DARDEN. Do you think it can be reasonably predicted in order to achieve an ASAT capability?

Mr. KENDALL. Yes. I think they can.

Mr. DARDEN. Finally, could you give us a reasonable prediction as to how long, given the funds that you request, without crippling amendments in the testing area, you think it will take before you can achieve an acceptable ASAT capability?

Mr. KENDALL. Unclassified, I can give you the mid to late '90s date and I can give you an answer for the record or later in closed session with more detail.

Mr. DELLUMS. Thank you. The chair recognizes Mr. Kyl for such time as he may consume.

Mr. KYL. Mr. Chairman, in view of some skepticism on your part that obviously continues, I'm not sure I can say there is an emerging consensus here, but in view of the remarks of Mr. Foglietta and Mr. Darden, former Secretary Carlucci identified this as the number one priority.

Mr. DELLUMS. If you would yield, the chair's questions are designed to elicit a discussion and communication. At this point it is important for us to determine what is before us before we decide whether we are for or against it.

Only a fool is for or against something they don't know anything about. It is our responsibility to become educated in this room. At that point, against the backdrop of an enlightened debate, we can decide.

The chair's point is to elicit information. After we have that, you will be enlightened as to the position of the chair.

Mr. KYL. There is a difference between the chair's skepticism and the chair's outright opposition.

Back to this point, one of the reasons Mr. Bennett touched upon briefly, I wanted to compliment him on one thing he brought up, and then make a point on that. One of you gentlemen alluded to the fact that there were back-up systems. Recognizing the fact that while the satellite capability is critical, that nonetheless, we recognize its inherent vulnerability and that there are some backup systems. Can you add anything to that to assure people like Mr. Bennett and myself that we have not entered into an age where everything depends on one critical item that can be eliminated.

General PIOTROWSKI. I can attempt to address that and could do so in a written response for the record more fully. Clearly we depend on satellites for communication today. It is the most time sensitive. On the other hand, there are terrestrial systems which are somewhat hardened against nuclear blasts.

So there are means of communicating without depending on space. However, they are not as convenient, not as small and, therefore, space is the preferred system for surveillance conducted by threshold means as well as by space.

Space is more timely, more ubiquitous. We have found ourselves putting more and more of our capability in space because by and large it is less expensive.

Mr. KYL. These would be good in written form because I think they would be helpful in assuring Mr. Bennett. Communications is so much better when in space. This brings me to the observation that it seems to me if a consensus is emerging, one of the reasons is an appreciation of the vulnerability of land and sea based forces,

the benefits of satellites and the importance of denying our opposition their ability to interfere with our Lance in a tactical mode.

If you would like to comment on that further, please do. But we are not talking here of a strategic situation but a tactical, correct?

Mr. KENDALL. Absolutely correct. One of the problems we had in convincing the Congress to support ASAT is that the debate generally has been conducted in strategic terms. This is a mistake. It is a tactical system in the true sense.

Mr. KYL. I will talk to Mr. Bennett about this later, but if you are talking about anything other than an all-out holocaust situation, you have to win by slogging your way through. That means you have to rely upon the capability of satellites. You need some backup for that as we discussed here, but slogging through means winning the tactical fights on sea and on land. That means this capability in today's climate, the program Secretary Taft approved for Milestone Zero is part of the overall strategic review, I assume.

I ask for your confirmation of that.

Mr. KENDALL. Yes, ASAT and general space control will be included in that review.

Mr. KYL. Obviously, Mr. Scowcroft is an integral part of that review.

Mr. KENDALL. Yes.

Mr. KYL. In response to some of the questions that the chairman asked that included some of the views of Mr. Scowcroft that certainly he will be involved in this review process and the consensus will emerge and Mr. Scowcroft will be part of that consensus.

Mr. Chairman, I had some other questions specifically relating to what we know about the Soviet's capacity, ASAT capacity with respect to our geosynchronous orbit assets.

I presume we cannot get into that in this session. If that presumption is correct, I think I will defer. I do think it is necessary to have a closed session so that we can get into some of these items.

Mr. DELLUMS. The chair would indicate to my colleague that when we call for an open session it would also be the chair's desire to keep that open to the extent possible. That is the way we advertised it. It is truth in advertising.

As I have said, I have indicated to the gentlemen that we would be more than willing to provide for an opportunity to the gentlemen for a closed session. If time does not permit us to do it this morning, we will schedule at the earliest practical date an opportunity to have that take place.

I would like to announce to my colleagues in the event that you have not received the information with respect to the change of time on the closed hearing on the strategic warning, that will be the subject of a joint meeting between the procurement panel and R&D. It will take place at 1:30 this afternoon rather than 2 p.m. Instead of 10 a.m., we will convene tomorrow morning at 9:30 in this room.

With those corrections, the chair now recognizes Mr. Hochbrueckner for such time as he may consume.

Mr. HOCHBRUECKNER. Thank you, Mr. Chairman.

Is the goal of the ASAT program which, as you pointed out, is spread between the Navy and the others, to physically destroy the satellite or blind it by in essence overloading the front end?

General PIOTROWSKI. The goal of the kinetic energy program, which is our highest priority, is to destroy the satellite. A laser system would degrade or destroy the satellite by raising the heat level of the satellite to the point where it destroyed components.

Mr. HOCHBRUECKNER. So the goal is total obliteration as opposed to destroying its capability by weighting out the front end through overload?

General PIOTROWSKI. You are correct. The kinetic vehicle would overload and destroy the satellite.

Mr. HOCHBRUECKNER. It was said that the magnitude of capability to destroy the geosynchronous satellite would be 400 times greater. The lower one, I assume using the same philosophy, that you are out to destroy the satellite. What kind of quantum level of additional energy would it take just to blind a geosynchronous satellite rather than taking it out entirely?

Mr. KENDALL. I will have to give you that for the record. The problem with that activity is that it is impossible to tell how well we have done. For that reason we would like to go to low earth orbit so we could be more confident.

Blinding might be something we would attempt to do if all else failed, but we would be far more comfortable with a smaller mechanism which gives us more confidence.

Mr. HOCHBRUECKNER. Obviously what you are admitting is that the same system that could take out a low level satellite in terms of destroying could be used against a geosynchronous if the goal was blinding it?

Mr. KENDALL. I don't believe it could, but I would have to answer for the record because we have not looked at it. Doing some quick mental arithmetic, I think it would require an increase in capability to get to a blinding capability at geosynchronous.

We will give you that for the record.

[The following information was received for the record:]

ANTI-SATELLITE (ASAT)

The U.S. ground-based lasers presently under development would [deleted]. These calculations assume the most favorable case, with the ground-based laser on the equator, directly under the target satellite. With these two laser systems, there is [deleted]. Similar to geosynchronous targets, atmospheric blooming will further degrade the energy felt by the target in these high altitude, highly elliptical orbits when ground-based laser device power is increased, because the beam director's slew rate to track these targets is so very small as to be essentially stationary to the earth.

Mr. HOCHBRUECKNER. The chair arranged a very interesting presentation to us on lasers. Certainly that is the kind of weapon that you are talking about here in terms of ASAT. The impression that you were leaving with people is that the ability of taking out a low level satellite is appreciably different. There is no question it takes more power, more rubber lenses and greater focusing with a laser to take out a geosynchronous satellite in terms of destroying the front end.

That is where we get into the hardware considerations versus the political considerations of should we or should we not have an ASAT. I believe any system you could produce that would take out a low level satellite could be adapted to taking out the high level satellites.

There is more here than just taking out the low level. If we go with ASAT we are working with a system that could take out both satellites.

If we pursue that, where do we go from there? I understand the basic logic. It makes a lot of sense and it is easy to sell to the American people, that is if you develop an ASAT system, it gives you the ability to take out their satellites. So they don't know where our fleet is, they don't know where our ground forces are, and they can't destroy either of them.

There are a variety of surveillance measures that the Soviets have to know where everything is. They are working on measures to make this as transparent as we are. There are many things going on with satellites that are useful for detecting where things are.

Let's assume that we develop an ASAT, you go ahead, we do a FEL, and we can take out any satellite we want.

Let's assume the Soviets do the same thing, and we both have these systems in place. If we pursue this logically it seems to me that we are saying at some point one side or the other might use their system and take out key satellites.

If that is the case, if we discovered our major satellites are going, or our BSTS is taken out by their system, then this is a prelude to a major conventional attack or a nuclear attack.

If that is the case, it seems to me the only response that would ultimately result from that kind of an attack would be a major nuclear exchange, World War III.

If that is the case, does not our present nuclear deterrence triad provide the sufficient deterrence that has worked so well for 40-some years? In fact is not our nuclear deterrence triad the best protection we have against our protection being taken out? If our satellites are destroyed, that is an equivalent to an attack on our forces. So does ASAT buy us anything besides additional escalation in producing a capability that neither side dares use?

Is ASAT any different than using additional nuclear warheads that you dare not use? It makes sense to say tactically, if we can take out their satellites they don't know where our fleet is. So we are a little safer. But, if they have the ability to know where it is through other mechanisms, what does it really buy us overall?

As the chairman pointed out, that is the purpose of the R&D subcommittee—to look ahead in the future and decide does it make sense to do this at this point.

I can see how someone can say if we take out their satellites they don't know where we are. I was in the Navy. I was on a carrier, and I appreciate that. I just wonder if the investment of dollars really buys us anything in light of the overall surveillance capabilities that they already have as well as the nuclear deterrence triad and even Star Wars. Does this really buy us anything? It is not clear to me that it does.

Mr. KENDALL. With regard to growth to geosynchronous capability, I can assure you the system we are talking about would not have any significant geosynchronous capability. If we did desire to proceed in that direction, we would come back to Congress for the funds.

Mr. HOCHBRUECKNER. But you are not disagreeing that developing the basic system to take out low level satellites could also take out geosynchronous?

Mr. KENDALL. It is a substantial lead time.

Mr. HOCHBRUECKNER. Once you get the basic capability, it is a matter of more power on target.

Mr. KENDALL. There are some other technical issues, as well, associated with tracking which would require significant improvements separate from the laser device.

It is a major step to go from the level we are talking about to geosynchronous. The other has to do with other means of surveillance the Soviets might employ. The space surveillance systems give them a better way to find our assets, ground or sea based, than other means.

It is a major force multiplier for them to be able to target a Soviet submarine from a satellite and allow that submarine to engage.

The other ways they would attempt to do that job are more inefficient, more costly. The support we have for the ASAT from the services, Army and Navy in particular, demonstrates that conclusively.

Mr. HOCHBRUECKNER. Are you suggesting right now that the Soviet Navy doesn't know where every one of our ships is located within a mile?

Mr. KENDALL. Right now, we are not making any attempt to deny them that knowledge. In a war time situation we would do that. We could do something about their other means of surveillance with the exception of the satellites currently.

Mr. HOCHBRUECKNER. If we make the assumption that we will not initiate a war, and that is a true assumption, only they would initiate a war, so they would know where every ship was as well as all of our missiles, B–1s and B–2s. So any movement at all they would track. I am not certain what having surveillance headlights would be worth.

I am not sure it is not equally provided through other mechanisms.

Mr. KENDALL. I do not accept the hypothesis that all our assets are at severe risk at the start of a conflict. You have to look at a longer term scenario, particularly in conventional war, where we would be sending convoys to Europe.

I would like to give you a more detailed answer for the record.

[The following information was received for the record:]

ANTI-SATELLITE (ASAT)

The Soviet Union employs a vast array of land, sea, and space reconnaissance and targeting sensors [deleted].

Mr. DELLUMS. Would you yield?

Mr. HOCHBRUECKNER. Would I dare not, Mr. Chairman?

Mr. DELLUMS. It seems to me that the gentleman was asking a more basic question that somewhere along the way was lost in the exchange. The chair thought he heard you asking a more fundamental question: whether or not pursuing ASAT was pursuing a war-fighting strategy as opposed to a deterrent strategy and what

the efficacy of pursuing a war-fighting strategy is? Is that the point of your question?

Mr. HOCHBRUECKNER. Mr. Chairman, you framed it so much better than I.

Mr. DELLUMS. Thank you. Is that a quantum change in the nature of our nuclear policy? What are the implications of a nuclear war-fighting strategy?

Mr. KENDALL. Thanks for bringing us back there. It is not part of a nuclear deterrent. That is why we want to see the debate going away from nuclear aspects of ASAT to the conventional. Like all our forces, ASAT provides a deterrent. I would like to divorce that from the nuclear aspect entirely.

ASAT is not intended for that.

Mr. HOCHBRUECKNER. The problem I have is where does tactical end and strategic begin? It seems to me as you say your major argument right now is that the use of the ASAT is a tactical device. I accept that because from a strategic side it doesn't make sense, but from a tactical side it makes sense. If they took our major satellites out, would that not in fact exceed the threshold of pushing us into a war? You don't do that because it is fun. You do it because you are going to make a major conventional or nuclear strike.

In that case, we are in it, and it just doesn't seem clear to me what it does for you.

General PIOTROWSKI. Sir, if I understand the thrust of your question, if I reported to the Joint Chiefs of Staff or the Congress or Secretary of Defense tomorrow that there was strong evidence that the Soviets had taken out one of our satellites that there would be response to execute the SIOP, the leadership of this Nation recognizes that that would invite our destruction.

The loss of a satellite would not automatically, no matter what satellite it was, lead to the release of their strategic nuclear forces because I am sure they would expect our retaliation to be swift and certain.

I have to put it back on the tactical issue. There are a number of steps on that escalatory ladder. A robust, capable anti-satellite capability on the part of the United States would have to be a deterrent to Soviet space and terrestrial aggression.

Then it does give the U.S. a war-fighting capability at the tactical level to be able to blind their targeting systems, and give us a better chance.

I would welcome the opportunity to ask the Navy to provide a full response about how good the Navy is at deceiving an ocean reconnaissance satellite. How good are we are at deceiving the Soviets? There is no question in my mind that even with loss of ships, loss of satellites or submarines, this Nation would not automatically spring to war.

As the chairman mentioned, we are only talking about one aspect of our space force structure. We touched briefly on more rapid response, on orbit spares perhaps in deep space where they could be more survivable to recall them.

Increasing the size of constellations to make them more resilient to laser and electronic warfare and the like, we are addressing one important aspect, but a larger discussion would have to include all those.

I would have to say my military experience would not lead me to say this Nation would react to the loss of 1, 2, 4 or 5 satellites with a nuclear response.

Mr. HOCHBRUECKNER. I am not suggesting that we go to war. They are not going to take out one satellite if they had an ASAT system, nor would we, but clearly you would use ASAT to take out major satellites to move into a conventional or nuclear attack.

So therefore, there is a threshold. I don't know where the tactical ends and the strategic begins. I spent 25 years in the electronics business and I know for every action there is a reaction and for every measure there is a countermeasure.

There is a whole measure of opportunities to defend your opportunities so the other guy's weapon cannot take you out. Whether it is heat shield or Zenith diodes at the front end to protect from overloads. These are all things to consider before you go to the ASAT system.

General PIOTROWSKI. If we are in a conflict in your opinion, and we are not able to resupply because of the Soviets interfering with our convoys then we have the decision to go nuclear.

The ASAT here gives you the capability to lower the threshold from nuclear weapons.

Mr. HOCHBRUECKNER. I would be surprised if the Soviets only relied on satellites to determine where our convoys were. I imagine their submarines would play a role. Thank you.

Mr. HERTEL. I ask unanimous consent that I be reported as voting aye in giving the chairman authority to go into closed session.

Mr. DELLUMS. Without objection, the chair has a housekeeping matter to clear up before we proceed.

Mr. Kendall, you responded to my letter in your opening statement. I read briefly from the news release of the Assistant Secretary of Defense dated March 9., paragraph 5,

"MIRACL/Sealite beam director ground-based laser will undergo an upgrade beginning in fiscal year 1989 to provide a limited, inexpensive and near term ASAT capability."

My responsibility as chair of the subcommittee is to preserve to the maximum extent possible the integrity of the process. That not only goes to assure that every Member of this subcommittee participates in the process, that all points of view have an opportunity to be heard and that witnesses have an opportunity in a dignified forum to make their case, but also to preserve the integrity of the process and to jealously guard the Congress since we have a triumphant form of government.

It seems to me this is going forward without authorization. I realize that the reprogramming was done below the threshold, but I think that I can argue very intelligently that when you talk about near term ASAT capability that any effort that moves us toward a limited, inexpensive and near-term ASAT capability is a matter of Congressional interest and matter of Congressional concern.

I am brand new in this job, but I personally believe that I would be derelict in my responsibility if I did not say to you and the powers that be on the other side of this process that we want the Pentagon to come in here with a formal reprogramming request,

provide an opportunity for Members of this committee to vote it up or down in the open.

I don't suggest that there would be votes here to turn it down. I don't know where the Members would be. I have not polled Members. But if the chair is within his rights and prerogatives as a responsible Member of this institution, it seems to me we need to protect the integrity of the process.

I believe the prerogatives of the Congress of the United States have been bypassed. Let's not question motives at this point, that is not my desire, but a matter of clear Congressional interest is going forward without authorization or without a formal reprogramming request and I would suggest that no more funds be expended until such time as the formal reprogramming request is acted upon by the appropriate committees of Congress.

I listened carefully to your opening remarks and appreciate your remarks that a number of Members of the House and Senate support this program, but this is a democracy and for every member you find who supports it, you will find at least one or a half member who opposes.

So you have Members on both sides. It seems to me we ought to, in appropriate forum, vote it up or down. This was the reason we sent the letter. It was not an ideological reason for sending the letter. It was to protect the process.

As I said before, whether we agree or disagree, we will try to provide a dignified forum that allows you to have an exchange.

That respect has to be a mutual proposition. We believe that a formal reprogramming request is in order in a matter that is of clear Congressional interest.

Mr. KENDALL. I can assure you that the reprogramming was initiated in good faith, that it was within the purvue of the Department to take those actions. Your concerns will be discussed at a higher level than what is here at this hearing.

Mr. DELLUMS. I am not questioning motive. It is a response to what we evaluate as the process. I am not trying to make a soapbox other than to raise that one simple issue.

Mr. Spratt is a distinguished Member of the full Armed Services Committee. He is not a member of the panel. The gentleman has been here for a couple of days and has demonstrated his interest. The chair would like to allow my colleague to ask whatever questions he may have.

Mr. SPRATT. Thank you very much, Mr. Chairman.

Gentlemen, thanks for your testimony. It seems to me we have an SDI program and if we develop a ground based system such as the ERIS intercept system and if we go forward with other systems, looking at the SDI system which has potential funding for chemical based lasers and significant funding for DEW programs, then the elements of an ASAT program are contained with the SDI program, so stopping forward progress on ASAT will require that we substantially truncate the SDI program. Is that a correct assessment?

Mr. KENDALL. Many of the activities in SDI are similar. If one ends work on ASAT that could affect it, we are interested in a much earlier capability for ASAT. I mentioned mid to late 90s. I think as you are well aware, we testified that the first phase of SDI

would not be deployed before the late 90s or perhaps 2000. There is a difference in time frames.

Mr. SPRATT. If we develop an ERIS as a first phase and we have the potential for taking out satellites just as we have the potential for taking out reentry vehicles, over the North Pole, then we are doing the same thing. The system you are proposing for the kinetic system is a scaled-down system of the ERIS. So it would not be in violation of the ABM treaty.

Mr. KENDALL. You are getting into a conflict issue when you bring in the treaty. If you bring this in, you could add the mission to that, SDI. We have not structured the program in ASAT necessary to do that. We are pursuing ASAT as an independent requirement. I think that pretty well addresses what you had in mind.

Mr. SPRATT. The mid-term laser choice, I understand you are looking at the MIRACL for this?

Mr. KENDALL. MIRACL is a near term limited capability modification to a R&D facility that we are in the process of making. That will give us some deterrent capability and some limited real capability against some limited altitude satellites.

When we go into closed session, I can provide you with more detail.

Mr. SPRATT. Are we going into closed session today?

Mr. DELLUMS. Due to the lateness of the hour, we will have to do that at a later date.

Mr. SPRATT. Given the capability, hardening, manufacturability and upping the range of some systems in to higher orbits and basic effectiveness, I wonder if it is worth going with it.

Mr. KENDALL. The near term costs were small and it is in the design for the services to harden their system. I think I ought to let General Piotrowski talk about the military utility of the system.

General PIOTROWSKI. The principal target of the MIRACL upgrade which is a modest capability would be solar panels which would still be vulnerable even if they racheted up their altitudes by double. It would be a substantial job for the Soviets to double their altitude but the MIRACL would still have an impact against their solar panels.

Mr. SPRATT. It seems to me that if we had such a system and we were getting into this argument at the close of your statement there, we would be terribly tempted to use it because of the importance of our surface Navy.

If we use a forward deployed strategy and attempt to bottle up the Soviet Navy at the sea of Norway and the Baltic, do this aggressively, then we would be very concerned, it seems to me, about having the Soviet satellites tracking our battleships and other surface ships.

If we took out their EORSATS and RORSATS so they would not have the intelligence advantage, we would be taking out the eyes and ears of their present anti-satellite system.

I understand the RORSAT and EORSAT were used to target the MHB system.

General PIOTROWSKI. The same booster that launches the RORSAT and EORSAT launches it.

Mr. SPRATT. But it doesn't depend on it.

General PIOTROWSKI. No, sir.

Mr. SPRATT. Nevertheless, it seems to me if we had that capability for tactical war fighting reasons, we would want to take out their RORSATS and EORSATS. We would have a tactical advantage in removing theirs to protect our surface Navy. Keep the sea lanes open and support our forward deployed strategy. Wouldn't that make sense?

General PIOTROWSKI. That would be a deeply discussed tactical decision in that the capability that would be available in a modestly upgraded MIRACL laser would not give us but one shot a day.

Mr. KENDALL. Are you addressing MIRACL only?

Mr. SPRATT. NO, I am talking about all the programs.

General PIOTROWSKI. Oh, then one would look at the effectiveness trades in our position versus theirs and the length of the tactical situation, if it were to our advantage. You are exactly right, I am sure.

Mr. SPRATT. We would use them before we would risk our naval assets in a forward deployed strategy?

General PIOTROWSKI. It is hard to pre-judge that scenario but I would hope that we would use our tactical tools to protect our forces and prevail in a conflict.

Mr. SPRATT. Maybe that is what the debate ought to focus on. Do we want to have that capability? Is it essential to our need to maintain the sea lanes and the surface navy superiority over the conflict and forward strategy if we undertook it.

General PIOTROWSKI. I would agree, Ken. I would not leave out the ground forces as well.

Mr. SPRATT. I have a lot of other questions but I think they can be best answered in the closed session, so I will be back for that.

Mr. DELLUMS. The chair would like to indicate that a number of our colleagues have requested that questions be submitted to you gentlemen in writing. Without objection, it is so ordered. We will ask you to respond for the record.

[The following information was received for the record:]

QUESTION: The Joint Chiefs of Staff have stated that the United States should not abrogate the 1972 ABM Treaty, that it is in the net interest of the US to maintain the integrity of this agreement. Do you agree with this assessment? Why or why not?
ANSWER: The United States wishes to retain the ABM Treaty unless and until a decision is made to move beyond it, while conducting research, testing, and development as required, which are permitted by the ABM Treaty. Of course, we also retain our existing right under the Treaty to develop and test certain ABM systems regardless the basing mode.

QUESTION: Do elements of the ABM Treaty need to be strengthened? If so, is it in the interests of the United States to negotiate with the Soviets to strengthen the treaty?
ANSWER: The United States' proposals in the Nuclear and Space Talks, taken as a whole, offer a means for a cooperative transition to greater reliance on defenses. We insist, however, that the Soviet Union correct its violation of the ABM Treaty involving the Krasnoyarsk radar in a verifiable manner before we will conclude any further strategic arms control agreements with the Soviet Union.

QUESTION: The original vision of SDI--to develop a defense to make nuclear weapons "impotent and obsolete"--has been pushed far into the future, if ever. The goal of the SDI program has been explicitly downgraded by most in the defense community, including the Joint Chiefs of Staff, to one of increasing deterrence and complicating Soviet attack against military targets. Do you agree with this assessment? Are there not other, less expensive, ways to reduce the vulnerability of US strategic forces and c3 assets to Soviet attack. If so, then what marginal benefit is obtained from a first-phase BMD deployment, in light of its considerable costs and competing US defense needs?
ANSWER: From its beginning, the SDI Program has had the same overall goal--to conduct a vigorous research and technology program that could provide the basis for an informed decision regarding the feasibility of eliminating the threat posed by ballistic missiles of all ranges and increasing the contribution of antiballistic missile defense systems to United States and allied security.

The Joint Chiefs of Staff (JCS) formally provided operational requirements for Phase I of a Strategic Defense System (SDS) in June 1987. The initial requirements acknowledge and confirm the long-term objective "to develop a thoroughly effective defense that will protect the United States and its allies from the threat of attack from ballistic missiles of all ranges" and also prescribe a minimum performance level which must be achieved in the first phase of deployment.

## Dependency on Space Systems

Question: You testified that the Soviets are increasing their reliance on space more rapidly than the U.S. is. Please provide for the record the following statistics.

- Percentage of Soviet and U.S. military communications were carried by satellites in each of the past five years.
- Percentage of Soviet and U.S. military communications that the U.S. expects would be carried by satellites under wartime scenarios. (An expected range of percentages will suffice.)
- Percentage of Soviet and U.S. photographic reconnaissance conducted by satellites in each of the past five years.

Answer: The actual percentages are highly classified. Both the United States and the Soviet Union depend heavily on space systems for such key functions as communications, missile launch detection, navigation, surveillance and environmental monitoring. The Soviets have thoroughly integrated these vital space support functions into all aspects of their operational planning, and their peacetime as well as wartime military operations.

While the Soviets have maintained terrestrial alternatives to some space systems, they fully recognize that the speed, accuracy and wide area surveillance capabilities of space systems are superior, especially in time of war. Having recognized their importance, the Soviets have developed and maintain a space launch infrastructure which also gives them the capability to reinforce rapidly their space order of battle, particularly their highest value surveillance and targeting space systems.

## Deterring Attacks on Satellites

Question: You testified by a U.S. ASAT would enhance the survivability of U.S. satellites by deterring attack on U.S. satellites. Why must deterrence of Soviet attack on U.S. satellites involve a tit-for-tat response? For example, why not send a conventional cruise missile against a Soviet target on land (e.g., a satellite control station)?

Answer: Past military exercises have repeatedly demonstrated that in the absense of a U.S. ASAT capability, the United States has two choices if the Soviets attack and destroy one of our satellites -- do nothing or take some other military action that could be dangerously escalatory. Destroying a Soviet terrestrial facility would probably cause the loss of Soviet lives and this would be a poorer response in kind to the loss of a U.S. satellite, than the destruction of a Soviet satellite. Furthermore, all the Soviet terrestrial facilities -- with the exception of their space support ships -- are located in the Soviet Union. An attack of these facilities would be an attack on the Soviet homeland. This could escalate rather than stabilize the situation. The National Command Authorities would have to weigh this risk before the order was given.

## Soviet Launch Infrastructure

Question: You noted that the Soviet Union has a much more extensive military space infrastructure than the U.S., currently sustaining a satellite launch rate about ten times larger than that of the U.S. Does this not mean that the Soviet Union would be able to

rapidly reconstitute satellites that are destroyed? If not, why not? If so, what is the lasting military value of a U.S. ASAT?
Answer: The Soviet launch infrastructure allows them to rapidly place satellites in orbit. The Soviets could certainly increase the number of ocean reconnaissance (radar and electronic), photo reconnaissance and electronic collection satellites on orbit, enabling them to locate and target our battle groups, divisions, and air wings. In the event of a shooting war with the Soviets, there is significant military value to a substantial U.S. ASAT capability, because of the Soviet replenishment capability. Militarily, it would be as prudent to destroy these space-based sensors, if required, as it was to shoot down observation balloons over the battlefield of the 1800s or the unarmed reconnaissance biplanes of World War I. But a limited U.S. ASAT capability would not be effective -- we must develop ASAT capabilities and technologies capable of offsetting the expected Soviet level of replenishment. If we fail to develop and deploy an ASAT capability, we could only prevent the Soviets from replenishing satellites by attacking their launch and command/control centers -- a military action which could be dangerously escalatory.

ERIS GBI as an ASAT

Question: Please describe the capabilities and limitations of the ERIS ground-based interceptor as an ASAT. Discuss for the ERIS Flight Test Vehicle and for the production version of ERIS. In particular please address the lethal envelope of each of these vehicles as an ASAT. What are the ways in which the production version for ERIS, optimized for ABM purposes, is not optimal for ASAT purposes? How severe are these limitations? What would need to be done to reconfigure ERIS as an ASAT system optimized for that purpose?
Answer: The ERIS FTV and ATV test vehicles have virtually no military utility as an ASAT. They are experimental vehicles designed to emulate the performance of a SDS Phase I Ground-Based Interceptor (GBI) and fly an observer package alongside the kill vehicle. Their flight paths require careful planning to keep from exceeding the flight envelope of the airframe (converted Minuteman I 2nd and 3rd stages). The onboard LWIR seeker has a narrow field of view optimized for highly capable SDS optical surveillance sensors, not those radio frequency (RF) radars available in the Space Surveillance Network (SSN) today. The entire ERIS flight test series has been developed to address the intercepts of reentry vehicles in sub-orbital trajectories not satellites in orbit.

In addition, there is no command and control system available at the test site (USAKA) to conduct an ASAT mission; there are insufficient booster assets to make more than a few additional ERIS test vehicles; there is no provision for rapid refurbishment for the reload of the single launch pad; and any use of USAKA ERIS launch facilities at Meck Island for ASAT would effectively stop SDIO testing there because of the limited space available.

It is theoretically possible, however, with enough planning and sufficient dedication of space surveillance assets, for an ERIS FTV to intercept a satellite in a limited altitude band. Such an intercept would not demonstrate real military utility. It also would not be at an altitude where the principal Soviet surveillance threat exists.

Principal Targets for MIRACL

Question: You have testified that the principal target for the MIRACL laser ASAT would be photovoltaic panels. Deleted.

Answer: [Deleted.]

Incidental Damage from DE ASAT

Question: You testified that you were not pursuing ground-based laser ASAT technologies that would cause such incidental damage that it would be difficult to make positive damage assessments. Please explain how you would be able to confirm that damage had been incurred on the photovoltaic panels of Soviet satellites that have been hit by the MIRACL ASAT?
Answer: There is no distinct cut off to the range of a laser. Some damage may be possible to satellites that are outside of the thermal hard kill envelope of the laser. [Deleted.]

Soviet Countermeasures to MIRACL

Question: One of the principal limitations of the F-15 launched ASAT was its short range. This meant that the Soviets could simply move their satellites to orbits beyond the system's reach. According to the Kendall Commission, MIRACL would also have an extremely limited range for ASAT applications. Would it not be a fairly simple and straightforward countermeasure for the Soviets to move their satellites that are threatened by MIRACL to orbits that are beyond that system's range?
Answer: [Deleted.]

MIRACL's Capability Against EORSATs

Question: Could a MIRACL ASAT reach EORSATs, [deleted.]

Answer: [Deleted.]

Soviet Satellites in Range of MIRACL

Question: Provide for the record which Soviet satellites would be within the range of MIRACL, and why they are high priority targets.
Answer: [Deleted.]

O&M Costs for MIRACL

Question: The Department of Defense issued a press release dated March 9, 1989 stating that it was pressing ahead with the MIRACL system "to provide a limited, inexpensive, and near-term ASAT capability." Please provide for the record the costs that were

derived by the Kendall Commission for operating and maintaining MIRACL as a ground-based laser ASAT.
Answer: [Deleted.]

Status of the MIRACL High Energy Laser

Question: You testified that MIRACL would not be an operational ASAT but that it would remain a research and development program. Which is correct, your testimony or the Defense Acquisition Board's announcement that MIRACL would be an operational ASAT.
Answer: As stated in testimony, the MIRACL/SLBD system is a technology development and risk reduction R&D program which has supported several ground- and space-based laser research programs in the past. The MIRACL/SLBD is not now, nor is it intended to become an operational ASAT. As an R&D facility, it will have a capability to engage very low altitude satellites, but will never be able to respond quickly and efficiently as would a system designed to be operational. The decision to upgrade the MIRACL/SLBD was made by Secretary Carlucci and was not part of the Defense Acquisition Board's (DAB's) deliberations.

Improving Soviet Space Threat

Question: You testified that the U.S. Navy faces a substantially greater threat from Soviet surveillance satellites today than it did a few years ago. My understanding is that there has been little if any appreciable change in the Soviet ocean reconnaissance activity. According to my information, the Soviets launched two RORSATs annually in 1984, 1985, 1986, and 1987, but only one in 1988 and none so far in 1989. They launched three EORSATs annually in 1985 and 1986, but only two in the years 1984, 1987, and 1988, and none so far in 1989. Please explain further why the Navy is more concerned today about the RORSAT/EORSAT threat than it was during 1984-1988.
Answer: [Deleted.]

The Navy's Requirement for ASAT

Question: As indicated by the Ranking Republican on the Subcommittee, the Navy did essentially no lobbying on behalf of ASAT during the congressional debates on this issue from 1984-1988, yet it was argued then, as now, that the Navy needed protection from Soviet satellites. It is only now that a Navy ASAT system has been proposed that we are hearing that the Navy is absolutely committed to the ASAT mission. Can you explain this please?
Answer: [Deleted.]

Damage to Geosynchronous Satellites

Question: You testified that you are not pursuing any ASATs that would reach beyond low earth orbit. You also testified that the Army has requested $15 million to pursue ASAT applications of the free electron laser. Wouldn't a free electron laser, as currently being pursued by the SDI, have applications as an ASAT against satellites to geosynchronous orbit?

Answer: The U.S. ground-based lasers presently under development, including the Free Electron Laser (FEL), would not have the capability to damage strategic Soviet geosynchronous communication satellites or even "blind" those Soviet early warning launch detection satellites that reside in highly elliptical orbits.

Soviet communication satellites at geosynchronous altitude have no optical mission sensors (as with a launch detection satellite), so high energy laser damage would first be experienced by the antennas or satellite structure. The high energy laser beam's intensity at the target must significantly exceed 1 solar constant (150 milliwatts/$cm^2$) over an extended period of time to impair a geosynchronous satellite, as geosynchronous satellites must be designed, at a minimum, to be exposed to 1 solar constant 24 hours every day. [Deleted.]

This calculation assumes the most favorable case, with the ground-based laser on the equator, directly under the target satellite. With FEL, there is insufficient energy to damage any portion of the Soviet communication satellite in geosynchronous orbit. Even if the ground-based laser device power was increased beyond 2 megawatts, the effects of blooming in the atmosphere (experienced by a high powered laser beam pointing at a stationary point in space relative to the earth, such as a geosynchronous satellite), would dissipate the beam to such an extent that no increase in laser beam intensivty would be felt by the geosynchronous target.

Soviet launch detection satellites are designed to look at the limb of the earth with an optical sensor and search for the missile plume against the dark sky. Blinding the optical sensor with laser energy could negate the satellite's mission capability. Consequently, a high energy laser beam must point back along the limb (just above the horizon) to enter the field of view of the Soviet launch detection satellite's telescope. [Deleted.]

## Verifying ASAT Limitations

Question: You testified that an ASAT limitation Treaty would be "absolutely unverifiable." However, Maj. General Thomas Brandt, former member of the Joint Planning Staff for Space, Joint Chiefs of Staff, has testified that "we have an excellent capability to monitor the employment of the Soviet ASAT." Governments officials have said that a Soviet ground-based laser ASAT with geosynchronous capability would be enormous and easily verifiable. With lower power ground-based lasers, scientists have suggested that it would be fairly simple task to develop black box systems that would register any significant activity of a near-by laser. Please comment and provide further detail to your assertion about the verifiability of a treaty that strictly limited ASAT testing and deployment.

Answer: The statement by Major General Brandt referred to the actual use of the Soviet co-orbital ASAT. The Soviet interceptor is relatively small and is launched by a type of space booster that the Soviets use for other space launch missions. We do not know how many interceptors or boosters have been manufactured. The Soviet Union could maintain a covert supply of interceptors which could be readied relatively quickly for operational use. In addition, the fact that ASAT capabilities can be a by-product of systems developed for other missions could create problems of identifying what would be prohibited under testing limitations.

Soviet ABM Interceptor

Question: You stated that any Soviet ABM interceptor has an inherent ASAT capability, but those interceptors are nuclear-tipped. Is it not true that crossing the nuclear threshold for ASAT use would be a substantially different matter than using a kinetic kill ASAT or ground-based laser ASAT?
Answer: Yes, the use of a nuclear-tipped ABM interceptor would be a substantially different matter than using a non-nuclear KE or DE ASAT system. The point, however, is that the Soviets possess a variety of systems which have inherent ASAT capability.

Countermeasures on U.S. Satellites

Question: Radar is a simple technology that can be easily countered. [Deleted.]

Answer: The survivability features of specific satellites are highly classified to protect the viability of the features. Individual methods can only be discussed at the appropriate classification level. In a generic discussion, methods to recognize an impending threat have been developed, and appropriate responsive measures have been developed to counter this threat. The effectiveness of these measures can only be confirmed in an actual attack, however, so additional countermeasures are continually evaluated in the hope of further enhancing survivability.

ASAT in a Tactical Context

Question: You argued that the ASAT issue should be viewed in terms of conventional conflict, and not in terms of strategic conflict. However, isn't it true that reconnaissance satellites are inherently global in nature, looking perhaps at the European conventional threater one moment, but perhaps looking at strategic missile sites during a short time later? This being the case, one would think that ASAT attacks could be easily misinterpreted and perhaps trigger a strategic conflict that might otherwise be avoided. Please comment.
Answer: Although low altitude Soviet reconnaissance satellites are certainly global in nature, they cover a small strip of land as they circle around the earth, much as our U.S. Air Force SR-71 and TR-1 aircraft. These low altitude reconnaissance assets are designed to look for specific detail in theater areas of interest, such as a ship, tank or troop movements. If a low altitude reconnaissance satellite's orbit is left unperturbed, it will not cover the same area again for many revolutions and many hours later. As a specific area of interest or area of conflict evolves, the Soviet planner maneuvers the low altitude reconnaissance satellite(s) to pass over and observe that same area again and again. [Deleted.]

_] Clearly, these satellites are being used in a predominantly tactical role, although, most certainly in a day-to-day peacetime environment, they also provide collateral input to the strategic planner. A geosynchronous early warning satellite on the other hand, covers an entire hemisphere at one time and its role is very specifically strategic in nature as it watches for ICBM and SLBM launchers on a global scale. Attacking a geosynchronous satellite clearly has a different, and potentially provocative, connotation than attacking a low altitude reconnaissance satellite or aircraft.

Total ASAT Funding

Question: What is the total FY 90-91 funding request for ASAT technologies? What does the DoD anticipate to be the final deployed cost for each of the ASAT systems under development?
Answer: For the Army-led kinetic energy (KE) Joint Program Office, the FY 90-91 funding request is $218.9 million. For directed energy, the FY 90-91 funding request includes $55.0 million for the Army's free electron laser ASAT, $61.1 million for the Air Force's ASAT technology base and $85.2 million for the MIRACL/SLBD, although the latter funding will not exclusively be used for ASAT research. The final deployment cost for KE and DE ASAT weapon systems will depend upon the concept(s) selected at Milestone I now planned for December 1989 for the KE ASAT and FY 91 for the DE ASAT.

Funding Within SDI

Question: How much is being spent within the Strategic Defense Initiative Organization (SDIO) for ASAT-capable systems?
Answer: There is no money spent for ASAT within the SDIO budget. Both the kinetic energy and directed energy ASAT weapon programs leverage heavily upon the SDIO's technology and research efforts and funding is maintained in ASAT specific program elements (PEs). This approach to acquiring an ASAT capability has been done to eliminate redundant technology development programs and to keep total ASAT systems procurement costs at a minimum.

Investigation of Multiple Technologies

Question: Why is DoD funding so many different technologies (ERIS, FEL, MIRACL, chemical oxygen-iodine laser, etc.) for the ASAT mission? Can the U.S. afford to develop so many technologies?
Answer: The evaluation of multiple technologies (including risk reduction) for meeting a specific mission requirement is inexpensive compared to the total acquisition and deployment of the system(s) finally selected. To build the most cost effective system, all key alternatives must be evaluated. The Defense Acquisition Board (DAB) recently approved Milestone 0 for the ASAT program, which is the preliminary step within the acquisition process, leading to concept selection at Milestone I, and, if approved, to concept demonstration/validation.

Multi-Service Involvement

Question: Why has DOD decided to involve so many services and agenices (Army, Air Force, Navy, SDIO, DARPA) in ASAT development? How many personnel are involved in program management--and how much is being spent on program management--vs. actual system research and development? How much would DOD save by placing all ASAT R&D within a single agency?
Answer: The technologies to develop ASAT capabilities and the requirement for an ASAT weapon have involved the Services and several Agencies for a number of years. Each Service and Agency brings different strengths to the diverse technologies of ASAT. That is the prime reason a Joint Program Office (JPO) for the kinetic energy ASAT program was formed. At present, there is no benefit in placing all ASAT R&D under one agency as the DAB evaluates and approves each step of the ASAT acquisition program and the Defense Resource Board (DRB) evaluates and approves the funding requests for the ASAT budget each year.

Effect of Delayed Funding

Question: How much would it delay or endanger the ASAT program if Congress deferred all ASAT funding, without prejudice, and asked DoD to come back with an ASAT master plan that included a choice among these different candidate technologies?
Answer: If all ASAT funding was delayed by Congress, on-going contracts and in-house technology programs within directed energy and space surveillance mission areas would be seriously impacted. Much of this work is independent of final concept selection. The DoD considers the U.S. ASAT program to be of the highest priority, effectively structured, and carefully planned. The President's budget fully supports the March 6, 1989, DAB-approved Milestone O Acquisition Decision Memorandum (ADM), for fielding a kinetic energy and directed energy ASAT weapons system. As specified within the JCS validated February 5, 1988 ASAT Multicommand Required Operational Capability (MROC) and the August 19, 1988 DAB approved ASAT Mission Need Statement (MNS), the overall ASAT effort should eventually incorporate kinetic energy, directed energy and electronic warfare programs.

Funding for MIRACL

Question: How much is DoD requesting for the MIRACL laser in FY 90-91? Which service is paying for the MIRACL program in FY 89, considering that no money was requested by DoD in its FY 89 budget last year?
Answer: DoD is requesting $85.2 million for the MIRACL/SEALITE Beam Director (SLBD) in FY 90-91. In FY 89, the Army is providing $6.0 million for the operations and support and the Air Force has transferred $8 million to conduct R&D (non-ASAT related activities and system improvements).

DE ASAT Candidates

Question: What has happened to last year's candidate for the laser ASAT mission, the chemical oxygen-iodine laser (COIL)? What about the Excimer laser? Will the MIRACL revival mean reduced funding

for the other programs? If so, how does this affect DoD's plans for selecting a ground-based laser ASAT?
Answer: The COIL was one of several candidates for a ground-based laser ASAT device and is still under consideration, as are the single and repetitive pulse excimer laser devices and the Free Electron Laser. At the direction of Secretary Cheney (April 18, 1989), the SEALITE Beam Director (SLBD) upgrade at the White Sands, New Mexico High Energy Laser System Test Facility (HELSTF) will be delayed until FY 90. The funding in FY 89 will maintain the necessary day-to-day operations of the MIRACL and the beam director, and will support computer hardware modifications, software modifications, weather proofing improvements, and laser operations safety studies. No ASAT-unique work will be performed. Other R&D laser program funding was not reduced within the President's budget when Secretary Cheney moved the SLBD upgrade to FY 90. The FY 91 downselect scheduled for selecting a specific DE ASAT concept at Milestone I has not been changed.

MIRACL Upgrade Decision

Question: According to the Kendall Commission report, even an upgrade MIRACL "would only provide approximately one-fourth the required altitude and cross-range performance." If this is true, why did DoD change its position on the cancellation of the MIRACL program?
Answer: The Department of Defense decided that a low cost, very modest ASAT capability was needed, pending the development of an operational system that could meet the mid-term ASAT requirement. The MIRACL laser device was not planned for cancellation, and in fact, was recommended for retention within the Ground-Based Laser (GBL) Anti-Satellite Options Study ("Kendall Report"). The low cost modification essential pertained to the MIRACL's beam director, called the SEALITE Beam Director (SLBD). The SLBD upgrade will not provide an operational capability. Rather, it will only place at risk a few low altitude Soviet satellites, while requiring significant lead time for each shot. From the Department's perspective, the SLBD upgrade was a much more fiscally sound proposition compared to keeping a handful of the residual F-15 miniature vehicle (MV) assets in costly storage for a possible ASAT contingency option. Unlike the MV option, there is a great deal to be learned from the continuing development and engineering required to complete and test the upgrade.

Testing of MIRACL

Question: When does DoD intend to test MIRACL? Has a target satellite been selected?
Answer: Tests could occur in the spring of 1991. No target satellites have been selected.

Soviet Systems Vulnerable to MIRACL

Question: Does DoD envision eventual deployment of a MIRACL ASAT? What Soviet systems would it be able to attack?
Answer: No. The MIRACL/SLBD system is a technology development and risk reduction R&D program which has supported several ground- and space-based laser research programs in the past. The MIRACL/SLBD is not now, nor is it intended to become "operational." The upgraded

MIRACL/SLBD will only place at risk a few low altitude Soviet satellites [Deleted] , and be used on a contingency basis, subject to NCA approval.

Funding for FEL

Question: How much is SDIO requesting for FEL for FY 90-91?
Answer: The funds requested by SDIO for the FEL in FY 90 and 91 are $275.1 million and $302.0 million respectively, however, these figures are under review, pending DoD budget reduction considerations.

ASAT Potential of FEL

Question: What is the ASAT-capability for FEL, vs. its potential for ballistic missile defense?
Answer: The FEL is capable of scaling to the powers for the Boost-Phase Intercept mission of SDI. This is many times the power needed for the ASAT mission. In spite of the high power capability of the FEL, it cannot perform the ASAT mission without significant and costly changes to the optical beam control system. This is due to the differences in the physics of propagating a laser beam to a cooperative relay mirror versus attacking a uncooperative satellite.

Survivability of Ground-Based Lasers

Question: How long would ground-based laser ASATs survive a full-scale US-Soviet conflict?
Answer: Existing R&D and projected ground-based laser facilities (FEL) are not designed to survive a full scale U.S.-Soviet conflict.

FY 90 KE ASAT Funding

Question: What does the Navy want to do with the $94.6 million ASAT request for FY 90? Does the service know what technology it would utilize? On which platforms? How many ASATs would the Navy deploy, and on how many ships?
Answer: This series of questions (#14-17) are under investigation by the kinetic energy ASAT Joint Program Office (JPO) and are included within the overall evaluation of the sea- and land-based options for a ground-based ASAT interceptor. The kinetic energy interceptor Milestone I is planned for December 1989 when concept selection is planned. Prior to Milestone I, a Cost and Operational Effectiveness Analysis (COEA), an ABM Treaty compliance review, and a System Threat Assessment Report (STAR) will be completed to assist the Defense Acquisition Board on concept selection based upon a review of basing selection (land and/or sea), life cycle costs, and applicable sensor technology, as well as surveillance and battle management/$C^3$

Countering Ship-Based ASATs

Question: What could the Soviets do to counter a ship-based ASAT? Would it make more sense to deploy ASATs on submarines?
Answer: This series of questions (#14-17) are under investigation by the kinetic energy ASAT Joint Program Office (JPO) and are

included within the overall evaluation of the sea- and land-based options for a ground-based ASAT interceptor. The kinetic energy interceptor Milestone I is planned for December 1989 when concept selection is planned. Prior to Milestone I, a Cost and Operational Effectiveness Analysis (COEA), an ABM Treaty compliance review, and a System Threat Assessment Report (STAR) will be completed to assist the Defense Acquisition Board in concept selection based upon a review of basing selection (land and/or sea), life cycle costs, and applicable sensor technology, as well as surveillance battle management/$C^3$.

Attacking RORSATs

Question: Under what conditions would the U.S. attack Soviet RORSATs? Does the Navy believe U.S. satellites could survive a Soviet retaliatory ASAT attack?
Answer: This series of questions (#14-17) are under investigation by the kinetic energy ASAT Joint Program Office (JPO) and are included within the overall evaluation of the sea- and land-based options for a ground-based ASAT interceptor. The kinetic energy interceptor Milestone I is planned for December 1989 when concept selection is planned. Prior to Milestone I, a Cost and Operational Effectiveness Analysis (COEA), an ABM Treaty compliance review, and a System Threat Assessment Report (STAR) will be completed to assist the Defense Acquisition Board in concept selection based upon a review of basing selection (land and/or sea), life cycle costs, and applicable sensor technology, as well as surveillance and battle management/$C^3$.

Deployment of Ship-Borne ASATs

Question: DARPA and the Navy have apparently let contracts to study the possibility of blockading Soviet access to space by deploying ship-based ASAT in the South Pacific. Is this a realistic option? What additional systems (launch detection satellites, defenses of ships carrying ASAT weapons, etc.) would be needed to ensure a successful blockade of Soviet access to space?
Answer: This series of questions (#14-17) are under investigation by the kinetic energy ASAT Joint Program Office (JPO) and are included within the overall evaluation of the sea- and land-based options for a ground-based ASAT interceptor. The kinetic energy interceptor Milestone I is planned for December 1989 when concept selection is planned. Prior to Milestone I, a Cost and Operational Effectiveness Analysis (COEA), an ABM Treaty compliance review, and a System Threat Assessment Report (STAR) will be completed to assist the Defense Acquisition Board in concept selection based upon a review of basing selection (land and/or sea), life cycle costs, and applicable sensor technology, as well as surveillance and battle management/$C^3$.

Soviet Co-orbital ASAT System

Question: Have the Soviets ended their unilateral ASAT test ban, in effect since June 1982?
Answer: While it is true that the Soviets have not conducted an actual intercept using their co-orbital ASAT system since 1982, the component parts of the system -- including the tracking radars, launchers and launch systems, and on-orbit intercept techniques --

are routinely practiced or employed in the Soviet's substantial space program. [Deleted.]

Operational Status of Soviet Co-orbital ASAT

Question: Does the Pentagon believe that the Soviet ASAT system is still a threat despite six years without a single, full-scale operational test? How many currently deployed American systems have gone six years without a major test? If we had any such weapons, how much confidence would we have in them?
Answer: The Soviet ASAT system has been operational since 1971 and has demonstrated an effective capability to destroy low-altitude satellites where many critical U.S. space systems orbit. Their self-imposed moratorium on testing is possible only because they have a proven and deployed ASAT. Additionally, the component parts of the co-orbital system are routinely practiced or employed. Since the moratorium has not eroded their operational proficiency, we are certain the Soviets could resume testing to improve their system or employ it operationally at any time.

Regarding our confidence in a system that the United States has not tested for six years, we have fifty Peacekeeper ICBMs on alert today providing the backbone of our nuclear deterrent. Yet we have never conducted a complete end-to-end test of a Peacekeeper -- out of an operational silo, flying to maximum range over the North Pole, and detonating the nuclear warhead. Instead, we perform component testing, subcomponent testing, test launches from a test site, and procedural exercises. That "testing" generates the confidence that our nuclear deterrent force would work.

Soviet High Energy Laser Development

Question: What is the state of Soviet laser ASAT work?
Answer: [Deleted.]

Verification of Soviet Actions

Question: Would Soviet laser tests be verifiable under any conditions? For example, would the exchange of military observers, or the installation of "black boxes," enable the U.S. to verify Soviet actions?
Answer: Tests of both ground- and space-based laser ASAT weapons would be difficult to detect and could possibly be concealed. While an exchange of observers or installation of on-site laser radiation detection devices might facilitate identifying possible ASAT tests at locations where these were used, such approaches would not help identify laser ASAT testing at unknown locations. ASAT capabilities can be the by-product of systems developed for other purposes. This creates problems of identifying which systems would actually be prohibited under testing limitations. The fact that ASAT capabilities are inherent in some systems designed for other missions or are amenable to undetected or surreptitious development makes it extremely difficult, if not impossible to verify compliance with a comprehensive testing limitation aimed at eliminating tests of all means of countering satellites.

"Black Boxes"

Question: Are any of the national research laboratories working on such black boxes? Would additional funding help to move that work along?
Answer: We are aware of such efforts, but not familar with the details.

Problems with Intrusive Measures

Question: Has the United States explored with the Soviets the possibility of intrusive verification measures, such as those included in the Intermediate-range Nuclear Forces Treaty? Why not?
Answer: No. While the difficult verification problems associated with ASAT arms control might be decreased with the establishment of intrusive measures, in some instances these measures would cause other problems. Information regarding certain U.S. space systems that are associated with national security is among the most sensitive information within the government. Negotiated measures with the objective of enhancing verification of an ASAT arms control agreement might require access to U.S. space systems that were alleged by the Soviets to have ASAT capabilities, and hence create an unacceptable risk of compromising the protection of that information. Such measures could also have adverse effects on civil uses of space.

Visit to Soviet Laser Facility

Question: Has the United States requested a briefing on, or visit to, Soviet laser research sites?
Answer: In the Defense and Space Group, Nuclear and Space Talks, Geneva, Switzerland, the U.S. side proposed an "Open Laboratories Initiative" to help build confidence and decrease misunderstanding between the two sides concerning their respective strategic ballistic missile defense activities. The initiative suggested a commitment by both sides to a regular exchange of briefings and visits, on a reciprocal basis. [Deleted.]

Mission of a U.S. ASAT

Question: Does the Pentagon still hope to deter Soviet ASAT attacks? How does the deterrent mission relate to the mission of destroying RORSATs?
Answer: Failure to provide a response in-kind to potential Soviet ASAT use will perpetuate the existing situation in which the Soviet Union might attack U.S. and Allied space systems, believing that their space systems are not vulnerable to counterattack by a corresponding U.S. ASAT deterrent. In addition to their various ASAT capabilities, the Soviets also maintain space-based reconnaissance satellites whose primary purpose is to locate and direct attacks against U.S. and Allied terrestrial forces. In view of the fundamental importance of U.S. and Allied force projection in crisis and wartime, including the need for Allied reinforcement by sea, the protection of U.S. and Allied forces against such targeting is critical. Therefore, failure to prove a non-nuclear

response to counter Soviet targeting satellites undercuts our ability to deter conventional conflict.

## Military Superiority in Outer Space

Question: Should the United States attempt to gain military superiority in space? What would such an attempt cost? Would the United States suffer or benefit from an open-ended ASAT exchange?
Answer: Deterrence, not superiority, is the goal of the U.S. ASAT program. Failure to provide a response in-kind to the use of a Soviet ASAT would give the Soviets an uncontested capability to attack our space systems, secure in the knowledge that their systems are not vulnerable to counterattack. Additionally, although not weapons themselves, the Soviets maintain satellites whose primary purpose is to provide targeting information against our forces. The lack of an ASAT capability to hold at risk Soviet targeting satellites that directly support hostile forces undercuts stability and our ability to deter conflict.

Assumming that an "open-ended" ASAT exchange implies that both sides use their respective ASAT capabilities during conventional conflict, the United States would benefit from being able to respond in-kind to Soviet ASAT use and to negate, if required, Soviet targeting satellites. Without a U.S. ASAT, the Soviets could view space as a sanctuary from which the Soviets can threaten not only vulnerable U.S. and Allied space assets, but also the ground, sea and air forces so valuable to our ability to control escalation of conflict.

## Soviet Space Launch Capacity

Question: What role does the greater Soviet space-launch capacity have? Do the Soviets have an inherent advantage in an ASAT race because of this capacity?
Answer: A greater space launch capacity permits the Soviet Union to launch a greater variety of satellite systems at a faster rate than the United States during peace, crisis or wartime. This capability generally reflects the Soviet's need to launch more satellites than the United States, based on their less capable, shorter-lived satellites. Nevertheless, the resulting launch infrastructure would be particularly advantageous during crisis or war. [Deleted.]

In the event of a shooting war with the Soviets, there is a significant military value to a substantial U.S. ASAT capability, because of the Soviet replenishment capability. A limited U.S. ASAT capability would not be effective -- we must develop ASAT capabilities and technologies capable of offsetting the expected Soviet level of replenishment.

## Survivability Measures

Question: How much does the Pentagon spend each year to ensure the survivability of U.S. satellites? Aside from ASAT development and any arms control options, has DoD identified any steps we could take to increase the survivability of U.S. satellites?
Answer: Estimating the amount spent each year for survivability of U.S. satellites is complex and not easily quantified. Many improvements made to existing satellites involve both increases in performance as well as increased survivability. As an example, using a new focal plane which sees targets in more than one waveband allows an infrared satellite to do better identification of targets as well as providing resistance to jamming from laser systems. In another example, using a different communication frequency allows more information to be transmitted over a link, while at the same time making the communication link harder to jam. Also, satellite systems benefit from DoD technology programs to improve the capability and hardness of generic electronic components, because when new electronic chips are added to a satellite, they frequently are both more capable and more survivable than those they replace. Consequently, many upgrades to satellite capabilities, either through changes to a current system or by introduction of a new block or system, provide both performance and survivability enhancements in non-separable ways. This in-turn makes estimating the true expenditures for survivability features difficult and potentially misleading.

Satellite developers and operators are continually improving the survivability of their systems to meet the goal of assured mission capability. We are constantly assessing a variety of measures to enhance the survivability of our space systems from design and development through operation. [Deleted.]

## Protection of U.S. Satellites

Question: Would additional or improved Soviet ASAT weapons require the U.S. to take extra steps to protect its satellites?
Answer: Survivability measures for U.S. satellites are driven by threats to all elements of the system: the ground segment; the communication links; and the satellites. These threats can be either specifically directed at the satellite system or can be collateral effects of actions taken for other purposes. Examples of specific attacks on the system include: physical attacks on ground segment assets; intentional jamming of communication links; intentional blinding of optical sensors; and ASAT attacks against the satellites. Examples of collateral effects include: unintentional jamming of communication links because of other jamming activities; disruption of communication links, increased radiation levels, and blinding of sensors because of nuclear explosion effects; and the impact of debris generated by new launches or attacks on other satellites. Survivability measures for U.S. satellite systems must protect against all of these possible events. Many of the necessary survivability features designed into the systems serve for more than one threat. The incorporation of survivability measures is an evolving process which must address existing, emerging or unknown threats. Therefore, the incorporation of survivability measures is not solely dependent upon additional or improved Soviet ASAT weapon capabilities, but the diversity of Soviet threats which can disrupt, degrade and destroy U.S. satellites.

Consistency with Arms Control Agreements

Question: What are the arms control implications of an expanded ASAT program?
Answer: The U.S. ASAT program will be conducted in a manner consistent with all our international treaty obligations including the ABM Treaty, the Outer Space Treaty and the Limited Test Ban Treaty. All ASAT concepts will be reviewed through the existing compliance review process within the DoD to ensure such consistency.

Willingess to Negotiate with Soviets

Question: Is the Administration willing to discuss ASAT arms control with the Soviet Union? Have the Soviets ended their unilateral ASAT test ban, or withdrawn their offer to negotiate?
Answer: Consideration of ASAT arms control is currently part of the overall review of national strategy being conducted by the Bush Administration. While the Soviets have not conducted an attempted intercept using their co-orbital ASAT system since 1982, most component parts of the system -- including the tracking radars, launchers and launch systems, and on-orbit command techniques -- are rountinely practiced or employed in the Soviet's substantial space program. [Deleted.]

Consideration of ASAT Arms Control

Question: The Reagan Administration based its opposition to ASAT talks on its claim that a total ban on ASAT research, development, testing, production, deployment and use was not verifiable. Does the Bush Administration intend to look at options less complete than this total ban?
Answer: Consideration of options of ASAT arms control is currently part of the review of national strategy being conducted by the Bush Administration.

DoD Position on ASAT Test Ban

Question: What is the Pentagon's current position on an ASAT test ban? Would a test ban make sense if we could verify Soviet laser activities?
Answer: Based on the recommendation of the Defense Acquisition Board (DAB), the Secretary approved the need for the development of a U.S. ASAT capability. As in any weapons development effort, the DoD must conduct extensive and realistic ASAT testing to demonstrate to ourselves and our adversaries that we have a real military capability. The Soviets already have an operational system, which is why they have been able to declare a self-imposed moratorium.

On the issue of ASAT arms control, the Administration is currently reviewing all aspects of our national strategy, including a variety of arms control considerations. It is important to note, however, that ASAT capabilities can be a by-product of systems developed for other purposes. This creates problems of identifying what systems would actually be prohibited under testing limitations. Finally, the fact is we cannot, with full confidence, verify Soviet laser activities without unacceptably intrusive measures. Such issues are being incorporated in our review.

## Investigation of ASAT-capable Technologies

Question: Keeping in mind the high cost of developing three or more different ASAT-capable technologies for the same mission, should the Pentagon be required to select a single candidate technology before proceeding? How much of this duplication is due to a risk reduction rationale, and how much results from the services fighting for turf? Should control over all ASAT research be given to a single service?

Answer: The evaluation of multiple technologies (including risk reduction) for meeting a specific mission requirement is inexpensive compared to the total acquisition and development of the system(s) finally selected. To build the most cost effective system, all key alternatives must be evaluated. The technologies to develop ASAT capabilities and the requirement for an ASAT weapons system have involved the Services and several Agencies for a number of years. Each Service and Agency brings different strengths to the diverse technologies of ASAT. At present, there is no benefit for placing all ASAT R&D under one agency as the DAB evaluates and approves each step of the ASAT acquisition program and the Defense Resource Board (DRB) evaluates and approves the funding requests for the ASAT budget each year.

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## Military Superiority in Space

Question: Has the Pentagon given up the mission of deterring Soviet ASAT attack in hope of gaining military superiority in space? What will it cost, in the long term, to achieve and maintain such a superiority? Do the Soviets have an inherent advantage in the ASAT arms race because of their greater space-launch capacity? How great of a threat is the present Soviet ASAT system, which has not had a single operational test in the past six years? Would the U.S. suffer or benefit from an open-ended ASAT exchange?

Answer: Failure to provide a response in-kind to the operational Soviet ASAT would perpetuate the existing situation in which the Soviet Union might attack U.S. and Allied space systems, believing that their space systems are not vulnerable to counterattack by a corresponding U.S. ASAT deterrent. Additionally, although not weapons themselves, the Soviets maintain satellites whose primary purpose it to provide targeting information against our forces. Failure to provide an ASAT capability to counter Soviet targeting satellites that directly support hostile forces undercuts stability and our ability to deter conflict. Since deterrence vice superiority is the goal, the cost of achieving and maintaining superiority is a mute point.

Assumming that an "open-ended" ASAT exchange implies that both sides use their respective ASAT capabilities during conventional conflict, the United States would benefit from being able to respond in-kind to Soviet ASAT use and to negate, if required, Soviet targeting satellites. Without a U.S. ASAT, we create a Soviet sanctuary in space from which the Soviets can threaten not only vulnerable U.S. and Allied space assets, but also the ground, sea and air forces so valuable to our ability to control escalation of conflict.

The Soviet co-orbital ASAT was declared operational in 1971. [Deleted.] Although neither an actual intercept, nor an ASAT launch, has been conducted since

1982, all components are maintained in an operational status through exercises, associated use of other systems, and operational crew training. The Soviet co-orbital ASAT should be considered operational and a current viable threat.

ASAT Arms Competition

Question: How will a full-scale ASAT arms race affect U.S. and Soviet military programs? the ABM Treaty? future arms control negotiations? As an alternative to an ASAT arms race, will the Bush Administration consider a ban or limitation on ASAT technologies? Have the Soviets ended their unilateral ASAT test ban, in effect since 1982? Keeping in mind the Soviets have previously offered an ASAT limitation treaty, will the Administration be willing to discuss ASAT arms control with the Soviet Union in the near future? Would laser tests be verifiable under any condition?

Answer: This series of questions appears to assume that the development and deployment of an operational U.S. ASAT would cause the Soviets to increase their ASAT development efforts. Soviet space doctrine states that the "Soviet Armed Forces shall be provided with all the resources necessary to attain military superiority in outer space sufficient both to deny the use of outer space to other states and to assure maximum space-based military support for Soviet offensive and defensive combat operations on land, at sea, in air and in outer space." The Soviet Union is, therefore, fully aware of both the importance to the United States of military satellites and the severe impact of their loss upon the U.S. capability to alert and direct our military forces in the event of a war. This knowledge has prompted the Soviets to develop their ASAT capability. They certainly did not develop it based solely on the possibility that the United States would develop an ASAT capability of its own.

On the issue of ASAT arms control, the Administration is currently reviewing all aspects of our national strategy, including a variety of arms control considerations. Any comments on that review would be premature at this time.

Mr. DELLUMS. Mr. Kendall, just two things. First, I know you indicated that this matter needs to be resolved above your pay grade—indicate to them that we are requesting a formal response to my concern.

Mr. KENDALL. To your letter?

Mr. DELLUMS. Yes, now of the requests that I made just today——

Mr. KENDALL. Not to expend any additional money?

Mr. DELLUMS. To retrospectively ask for the money. Maybe I am one of the last of the westerners, but I believe the rules of the game ought to be rules of the game.

I have one final question, Mr. Kendall, and perhaps that is the way to conclude in open session because we are talking about general terms and policy.

I want to read from the conclusion of the Anti-satellite Weapons, New Window of Vulnerability in Space by John Pike, Associate Director of the American Science Foundation, February 17, 1978, conclusions:

"Despite 20 years of debate, those who are concerned about silo vulnerability have yet to implement a solution to this problem. A technological fix to the threat of satellite vulnerability would have, at a minimum had us scrapped the entire program with newer numbers and less expensive satellites, but it is open to question whether this approach would solve the problem. The other question is the role we did not take on multiple warhead missiles and arms control. There must be an immediate ban on the testing of weapons capable of intercepting satellites, currently those under the ABM treaty."

Can you comment, Ken?

Mr. KENDALL. Linking ASAT to nuclear deterrents and especially nuclear stability I assume is the assumption that prompted those remarks, and I disagree with that assumption.

Mr. DELLUMS. You are saying that this ASAT program has nothing to do with strategic capability. This is conventional?

Mr. KENDALL. It has to do with conventional deterrents and deterrents of Soviet understanding of their ASATs, but I would not link it to satellites.

Mr. DELLUMS. The subcommittee will stand adjourned until 12:30.

[Whereupon, at 11:55 a.m. the subcommittee was adjourned.]

# SUBMARINE AND ANTI-SUBMARINE WARFARE TECHNOLOGY—RDT&E BUDGET REQUEST FOR FISCAL YEAR 1990

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HOUSE OF REPRESENTATIVES, COMMITTEE ON ARMED SERVICES, RESEARCH AND DEVELOPMENT SUBCOMMITTEE AND THE SEAPOWER AND STRATEGIES AND CRITICAL MATERIALS SUBCOMMITTEE, WASHINGTON, DC, TUESDAY, MARCH 21, 1989.

The subcommittees met, pursuant to call, at 10 a.m., in room 2118, Rayburn House Office Building, Hon. Charles E. Bennett, (chairman of the Seapower and Strategic and Critical Materials Subcommittee) presiding.

## STATEMENT OF HON. CHARLES E. BENNETT, A REPRESENTATIVE FROM FLORIDA, CHAIRMAN, SEAPOWER AND STRATEGIC AND CRITICAL MATERIALS SUBCOMMITTEE

Mr. BENNETT. The subcommittee will come to order.

A year ago last December, in response to concerns regarding the rapid improvement in Soviet submarine technology evidenced by developments such as their new Akula class, Chairman Aspin engaged a panel of 10 distinguished experts to advise us on this very important issue.

In the 15 months or so since then, the panel has thoroughly explored both submarine and anti-submarine technology, and is now ready to report its findings. To speak for the panel today, we have one of its members, Dr. William Perry, former Under Secretary of Defense for Research and Development and the Acquisition Executive of the Department of Defense.

Other members of the panel who are here today are Admiral Burkhalter and Dr. Paul Kaminski, President of the Technology Partners, Incorporated; Dr. Harold Rosenbaum, President, Harold Rosenbaum Associates; Dr. Harold P. Smith, President, the Palmer, Smith Corporation; Dr. Lowell Wood, Special Studies Program Leader, Lawrence Livermore National Laboratories; and Harry Jackson, a naval architect.

The other panel members who could not be with us here today are Dr. John Foster, Vice President, Science and Technology, who had to cancel at the last moment due to an illness in his family; Dr. George Heilmeier, Senior Vice President and Chief Technical Officer of the Corporate Research, Development & Engineering, Texas Instruments Incorporated; and Admiral Robert Wertheim, U.S. Navy, retired.

I want to take this opportunity at the outset to thank the members of the panel for their generous service to the committee and to the country. We greatly appreciate all the time and effort they

have personally invested in this effort. This committee feels like this is a very, very important subject of thought for our security.

I want to emphasize to the members the critical importance of this panel's finding. We are dealing here with an issue that, in spite of its immense significance to national security, has attracted only a tiny fraction of the attention accorded, for example, to Star Wars. It is high time that this issue be aired and we are grateful to the panel for doing just that.

After Dr. Perry makes his initial presentation, he and the other panel members who are with us today will then be available for our questions, but before turning the floor over to Dr. Perry, I would like to ask if Mr. Spence, Mr. Dickinson, Mr. Dellums or any of the other senior members who are here might want to make an observation about this, or even junior members.

Mr. SPENCE. Mr. Chairman, you have covered it very well. I would just like to welcome these gentlemen this morning. Thank you for coming.

Mr. BENNETT. Does anybody else have an opening statement they would like to make?

We will put the statements of the other gentlemen in the record.

PREPARED STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

I would like to join Mr. Bennett and my other colleagues in welcoming the members of the panel and thanking them for their excellent work on assessing the issues on advanced submarine and anti-submarine technologies. I am extremely pleased with the professional manner in which the study has been carried out and in my initial reading of the results. I have been stressing a more long range look at R&D matters and I believe the results of your study are very timely in helping the subcommittee resolve where we are going, with the long haul as well as this year's budget.

Again, I want to thank each of you for providing your time on this very important problem.

PREPARED STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER OF THE RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Thank you, Mr. Chairman, and thank you gentlemen, for appearing before the subcommittees today. Dr. Perry, you have testified before the R&D Subcommittee many times, and we are pleased to have your testimony again today.

This subject of submarine and anti submarine warfare technology is again going to be a difficult one for the Congress. In the past, both authorizing and appropriations committees have added money to the defense budget for submarine technology and for anti submarine warfare research and development. These additions have not been supported by either the Department of the Navy or the leadership in the Office of Secretary of Defense. In fact, this year it is my understanding that the Defense Department has not asked for any specific money for the advanced submarine technology program which the Congress initiated and funded for several years.

A basis for this committee's action last year was expressed in its report where it is stated that:

The advent of very quiet, long endurance submarines . . . presents a special menace to the United States because of the political and economic U.S. maritime links.

This subcommittee and the full committee need to have an understanding of the impact of quiet submarines because the upcoming defense budget debates will require our accurately knowing how to prioritize different programs.

Just last week I quoted from an article by former Secretary of Defense Frank Carlucci where he stated that in his opinion the "single most serious deficiency in our military posture" is our lack of having an anti satellites capability. I agree with Mr. Carlucci. It has been stated that Soviet satellites can detect and put our surface

naval forces at risk while Soviet submarines put the same forces at risk because of their weapons capability. Therefore, the combination of Soviet satellites with Soviet submarines could provide the most serious threat to our surface naval forces they have faced since World War II.

It may turn out you gentlemen will assess that the priorities are equal for anti satellite, submarine and anti submarine technologies, or that you assess the priorities for one above the others. However you asses these priorities, we need to have your testimonies in the clearest of terms so that there can be no confusion.

Finally, the context in which to take the assessments of Soviet submarines and anti submarine warfare advances is very difficult for us to evaluate. Not only are the Defense Department's requests for funding these technologies below what we have heard is necessary, there is also the issue of the Department of Navy's decentralized management of the anti submarine warfare programs.

Just recently the Congress received information that assessed the technological challenges posed by the evolving submarine threat as large. It was further asserted that these challenges will require sustained and focussed national attention to develop affordable solutions and that an orientation to isolated platforms such as ships, submarines or aircraft, will only result in limited improvements in anti submarine warfare effectiveness. Yet when we look at the organization inside the Department of Navy, it is therefore imperative again to have the clearest understanding regarding your assessments of the problems which face the Nation in this area, their relevance to our national security posture and your perceptions of how best to address the issues raised by these threats.

Thank you, Mr. Chairman.

Mr. BENNETT. We are delighted that you have come and it is very, very important and we will proceed, Dr. Perry, with your leadership.

## STATEMENT OF WILLIAM PERRY, H&Q TECHNOLOGY PARTNERS, INC., (FORMER UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING)

Dr. PERRY. Thank you, Mr. Chairman.

I should start off with a caveat by noting that I am not the chairman of this panel. We functioned in a true collegial fashion without a chairman, but I have been asked by the other panel members to make an opening statement. I would suggest that the questions the committee have could be directed to any of the members of the panel.

The primary objective of our anti-submarine warfare forces is to maintain our sealines of communications. I don't need to speak to this committee about the importance of maintaining sealines of communications.

For decades, the United States program in anti-submarine warfare has been a major success story. Indeed, I would call it a jewel in our crown. We have developed the best submarines and the best anti-submarine warfare program in the world and this has given the United States a very significant military advantage.

Most importantly, it has given the United States high confidence that we could maintain our sealines of communication even the face of a very determined assault on them. During all of this period, the Soviet Union maintained an extensive and an expensive program in both nuclear submarine design and construction and anti-submarine warfare.

In my judgment this is a very impressive program, but it has not succeeded in equaling the U.S. capability in these fields.

However, we have no room for complacency. The Soviets have, in the last few years, and I might say belatedly, begun fielding a quiet nuclear submarine. I should emphasize that the United States still

has a lead in submarine-quieting technology. The important point, however, is that the Soviet subs are quiet enough to give our anti-submarine warfare system a real problem.

It is fair to say that the submarine/anti-submarine warfare game has changed as a result of this introduction.

The United States has developed extensive and very effective ASW systems which, however, were based on a very specific Soviet vulnerability. We use a network of passive hydrophones to listen to the noise from Soviet submarines and this has been the basis of our ASW program. This has served us well for many decades now, but the free lunch is nearly over with the introduction of quiet submarines in the Soviet forces.

We must now restructure our ASW systems to recognize this new reality. We have time to do that. The Soviets, to this date, have a relatively few quiet submarines in their fleet and it will take them many years, perhaps 5 to 10 years, to replace their noisy submarines with a significant number of this new class of quiet submarines. Therefore, the question comes down to what we should be doing during this period, this grace period, you might say.

The first point I would make is that there are diminishing returns on improving our passive sensor systems—on improving the hydrophones, which are now the basis for our ASW capability. We have already achieved very great sensitivity in these systems and the extra improvement that could be made with an intensive research program in that area would not really solve the problem.

Therefore, it is going to be necessary to develop new sensors, both active acoustic sensors and nonacoustic sensors. In addition to that, it will be necessary to formulate a new, as we call it, architecture, for the ASW system. By that, I mean, in addition to developing new sensors, we will need new processing systems and the communication network to tie them together, connect them to the fleet, and new operational tactics.

It is a fair question, and one to which the panel directed much of its effort, to ask how are we doing in achieving this new capability? First of all, I would tell you that as a result of our investigation, we concluded that there is an innovative and imaginative R&D program in ASW sensors under way. This is a very difficult technical problem with which we are faced, and I have been much impressed with the progress being made in that area, both in the Navy and in DARPA, which are spearheading the new sensor development work in this area.

That work should continue and it should be accelerated as appropriate.

The deficiencies are that we have not yet formulated the new architecture which would tie together the new sensors as they are developed, nor have we begun a vigorous program on what I would call the back-end of the R&D effort—picking up the ideas that have been developed, putting them into prototype form and testing them at sea. We, of course, do not yet have a deployment under way.

So the good news is that we do have ideas. We have a vigorous research program and are experimenting with promising ideas. We have not developed them to a sufficient extent. We have not put together an architecture into which these systems could be made operational.

Carrying out the latter phase of this program—the prototyping, the testing and the deployment of a new system—will be very expensive. We sense a reluctance, an understandable reluctance, to commit the resources necessary to enter this next phase in the ASW program.

We believe that the importance of fielding this next generation ASW system is so important that it should be given the priority which would allow it to have increases in budget, even in the face of a declining defense budget.

Now, with this assessment of the problem, Mr. Chairman, and with the report in front of you, I think the appropriate thing would be to turn over the floor to the chairman, and allow you and the committee to ask questions of myself and the other panel members.

[The following information was received for the record:]

# REPORT

OF THE

# ADVISORY PANEL ON SUBMARINE AND ANTISUBMARINE WARFARE

TO THE

# HOUSE ARMED SERVICES SUBCOMMITTEES

ON

# RESEARCH AND DEVELOPMENT

AND

# SEAPOWER AND STRATEGIC AND CRITICAL MATERIALS

MARCH 21, 1989

(UNCLASSIFIED EDITION)

MEMBERS OF THE PANEL:

VADM Edward A. Burkhalter, USN (RET)
Dr. John S. Foster, Jr.
Dr. George H. Heilmeier
Mr. Harry A. Jackson, P.E.
Dr. Paul G. Kaminski
Dr. William J. Perry
Dr. Harold Rosenbaum
Dr. Harold P. Smith, Jr.
RADM Robert H. Wertheim, USN (RET)
Dr. Lowell Wood

## EXECUTIVE SUMMARY

Aside from the deterrence of thermonuclear war itself, our commitment to aid in the defense not only of Western Europe, but also areas such as Northeast Asia and the Middle East, has long been the centerpiece of United States national security policy. The expense of the conventional forces that that commitment entails accounts for most of the defense budget.

To honor that commitment if challenged, we would have to move our forces overseas, perhaps to remote areas, and then resupply them with the materiel of war. Because we could not build enough airlift to move more than a tiny fraction of the tonnage involved, most of it would have to go by sea.

Thus, a major part of our long-standing national security policy requires that our sea lines of communication be secure in time of war. Air attacks are one possible means of interdicting them. This report deals with the other: attack by submarine.

Since the end of World War II, the United States has built the best submarines and had the best anti-submarine capability in the world. While our military shipping would no doubt suffer losses to submarines, we are confident that we could still reinforce and support Europe or other vital areas adequately if war were to break out today.

But whether we will still be able to do that in the future is becoming much less certain. And thus our future ability to carry out a major part of the national security policy that we have pursued for the past 40 years is becoming much less certain. Obviously, this is an issue of profound importance to the security of the United States.

Our current anti-submarine warfare (ASW) capability rests almost entirely on listening for the sounds generated by Soviet submarines. That approach has been successful and our antisubmarine forces have grown potent because the Soviets have traditionally built relatively noisy submarines. But the future of that approach to ASW is now very much in doubt because the Soviet Union has begun to produce quiet submarines.

Because the Soviets cannot build enough new submarines overnight to constitute a serious threat, we still have time to do something about the problem. But do something we must: we must build what will amount to an entire new ASW capability by the time the Soviet Union has built a significant number of new submarines.

The Navy is responding competently in researching technological alternatives to our current systems. But the Navy establishment -- like many organizations of comparable size and age -- is burdened with internal vested and sometimes conflicting interests that encumber innovation and execution on the scale required here. Business as usual is not up to an undertaking of this magnitude and importance. Dramatic new initiatives are essential if the problem is to be solved in time.

We believe that the Navy must, in effect, "start over" with new approaches to ASW. This is no ordinary challenge; it is of a different nature and on a different scale than most. What is needed is not simply more money and harder work, important as those may be; what is needed is an entirely new and aggressive architecture for coping with this immensely serious development.

The Congress should make sure that that happens and that the Navy raises the priority accorded ASW. It should encourage more vigorous development of our submarine technology, not just for the new SSN-21, but for future classes too.

The Defense Advanced Research Projects Agency (DARPA) is also working on both ASW and submarine technology. Because a diversity of approaches is prudent when the technological challenge is as formidable and the stakes are as high as they are in this case, DARPA's work should continue in parallel with the Navy's, but with DARPA -- in keeping with its traditional mission -- concentrating on the more advanced and riskier technological alternatives. But though independently managed, there needs to be better communication and coordination between the two programs.

The importance of this research justifies significant real growth in funding in spite of today's downward pressure on the defense budget. Indeed, with the maintenance of our ASW capability arguably the most important of all the challenges facing the DoD today, a case can be made that funding for ASW research should be determined less on customary grounds of compromise among many projects competing for limited resources than on grounds of what could usefully and efficiently be applied to this most critical of all R&D tasks. But whatever the level, the funding should be predictable, enduring, and stable.

By Congressional direction, the CIA has undertaken a novel role: basic ASW research and experimentation at sea. We believe that funding for the program should continue, but with a gradual shift away from basic research and back toward the Agency's fundamental mission of intelligence as other independent organizations become able to respond to the research and experimentation needs of the Agency. But to understand what data to look for, how to obtain it, and how to interpret it, the Agency must retain the scientific expertise that it has built over the past four years. It can do that by to continuing to participate in the planning and analysis of submarine and ASW research.

And finally, because of the critical importance of the issue and because of the number of technical, intelligence, and operational communities involved, we recommend that the Secretary of Defense appoint a broadly based standing committee of recognized experts in the relevant disciplines to advise him on the subject of ASW, including:

- The evolution of the submarine threat;
- Objectives, strategy, plans, and programs to deal with that threat;
- The adequacy of U.S. programs, management, and resources;
- The quality of U.S. research;
- The adequacy of coordination among the organizations involved; and
- Desirable actions and initiatives.

Further discussion of the issues in this summary is in the appendix.

APPENDIX TO THE REPORT
OF THE
ADVISORY PANEL ON SUBMARINE AND ANTISUBMARINE WARFARE
TO THE
HOUSE ARMED SERVICES SUBCOMMITTEES
ON
RESEARCH AND DEVELOPMENT
AND
SEAPOWER AND STRATEGIC AND CRITICAL MATERIALS

## SUBMARINE TECHNOLOGY

The initial motivation in forming this panel was a concern that Soviet submarine technology might be outstripping ours. At the time, antisubmarine warfare (ASW) technology, though also of concern, was of somewhat secondary interest.

But as our exploration progressed, it became increasingly clear that of the two issues, ASW was not only the more pressing but, indeed, a matter meriting the highest priority of attention. The bulk of this report accordingly centers on that issue, but that is not to dismiss submarine technology.

As to the original concern that Soviet submarine technology might be outstripping ours, it is true that the Soviets' submarine R&D program is extremely ambitious, seems to overlook no promising technologies, and -- in that it dates back for many years -- is no flash in the pan. As a result of their years of intensive research, it appears that the Soviets may well be ahead of us in certain technologies, such as titanium structures and control of the hydrodynamic flow around a submarine.

But far more important is the improvement that the Soviets have made in submarine quieting. The problem is not that Soviet submarines are now quieter than ours; they are not. But after decades of building comparatively noisy submarines, the Soviets have now begun to build submarines that are quiet enough to present for us a major technological challenge with profound national security implications.

Though we see no evidence as yet that the Soviets' ambitious R&D program has produced a submarine that is qualitatively superior to ours, their continuing, ambitious technology program may well produce such a submarine unless our own R&D efforts at least match theirs in scope and productivity.

It is true that, except in the case of direct submarine-to-submarine encounters, how well one side's submarines happen to stack up against the other side's submarines is much less important than how well they stack up against the other side's ASW capabilities. Nonetheless, submarine-to-submarine comparisons still have important implications for other than submarine-versus-submarine operations: a Soviet superiority would imply that we had not taken full advantage of what the Soviets had shown to be possible, and that the effectiveness of our submarines was therefore less than it could have been.

In our opinion, the Navy's current submarine technology program is unduly restricted to issues relating to the design of its forthcoming class of attack submarines, the SSN-21 *Seawolf*. While the importance of technological excellence in this new design is beyond question, we believe that more effort on research and development applicable to later designs is equally warranted.

The most fundamental issue in considering future SSNs is what their missions should be. The advent of very quiet Soviet submarines (as discussed below) threatens what has traditionally been the most important wartime mission of our SSN force: hunting enemy submarines. The possibility of mitigating that degradation through new technology and tactics needs to be considered now as we explore alternative designs for new SSNs. In addition, we need to consider other roles for submarines which, with their inherent stealth, can penetrate areas denied to surface ships and aircraft.

But whatever the future missions of SSNs may turn out to be, the opportunities for technological progress are rich and merit serious investigation now. We caution, however, that the objective must not be mere technological virtuosity, but real effectiveness at sea. For example, improvements in speed and depth capability, while possibly dramatic, might turn out to do less for combat effectiveness than an equal investment (dollars, space, or weight) in other kinds of improvements.

To one degree or another, work is indeed going on in such areas, both in the Navy and in the Defense Advanced Research Projects Agency. To the Navy's credit, it has decided to take an operational submarine out of the line and make it available for research and development projects. Though not on a scale with the revolutionary submarine *Albacore* built early 50s entirely for R&D purposes, the panel welcomes this initiative as very much a step in the right direction. But, nevertheless, it is our opinion that the Navy's submarine technology effort is still too narrowly concentrated on the near term, i.e., the SSN-21, to the neglect of even greater longer-term improvements. And, given the immense benefits that stemmed from *Albacore* and the growing importance of submarines, we believe that the Navy should resume experimental submarine programs for research into advanced technology.

The Navy's rationale for its emphasis on the shorter term is that it is the more pressing problem, and that full funding for both simply isn't available. But we believe that that is too narrow a view. First, much useful theoretical and experimental work can be accomplished at moderate cost. But second and more importantly, the premise that additional funding is not available assumes that the present general allocation of funds among all Navy claimants is somehow immutable. In terms of the authority to reallocate requests for funds within the Navy, of course it is not: the Navy leadership obviously has such authority. But in terms of politics within the Navy, the premise may be closer to the truth. Those who might suffer in a reallocation of funds to longer-term submarine R&D at their expense have apparently been successful in more-or-less holding the *status quo*.

We therefore recommend a program of research and development on submarine technology with the following characteristics:

1) Research on advanced submarine technology should continue in both the Navy and DARPA. The two should be independent in approach, but not in planning. Though both should be aggressive, DARPA's program should concentrate on the more venturesome projects involving higher risk but greater potential benefit.

2) The initial funding level should be no less than that of FY89, plus enough to support additional research by the Navy on submarine technology issues beyond those now being addressed in support of the SSN-21 development program. We emphasize, however, that the level at which these programs are funded is no more important than how well they are conceived and managed.

3) For both efficiency and productivity, funding for both of these programs should be established on a predictable, enduring, and stable long-term basis. Growth is advisable in a program with such rich possibilities and of such national importance, but growth is no more important than predictability.

We also note in closing that, in our opinion, the Navy's "in-house" technical community -- its laboratories and its shipyards -- has become too oriented toward maintenance of the existing fleet at the expense of research and development for the fleet of the future. For example, we doubt that it would be possible today to create the equivalent of the Special Projects Office that developed the Polaris system because we no longer have the technically trained officers experienced in ship design, shipbuilding, weapon development, and electronics who served then as the Special Projects Office department heads. We believe that the Navy should reestablish an "in-house" cadre of such technically proficient officers and civil servants.

## ANTISUBMARINE WARFARE

### The Decline of Passive Sonar

For decades, our principal system for detecting and tracking Soviet submarines has been passive sonar. The particular application that we and other nations have used depends on underwater microphones to detect the distinctive sounds emitted by a submarine's engine, propeller, turbogenerators, and other sources.

Our passive sonars have been able to detect the typically noisy submarines that the Soviets have built over this period at relatively long ranges. But the era of relatively noisy submarines is beginning to draw to a close. Not only are the Soviets finally beginning to build quiet submarines, such as the *Akula* class, but significant innovation is taking place in some Italian, German, and Swedish designs for non-nuclear submarines.

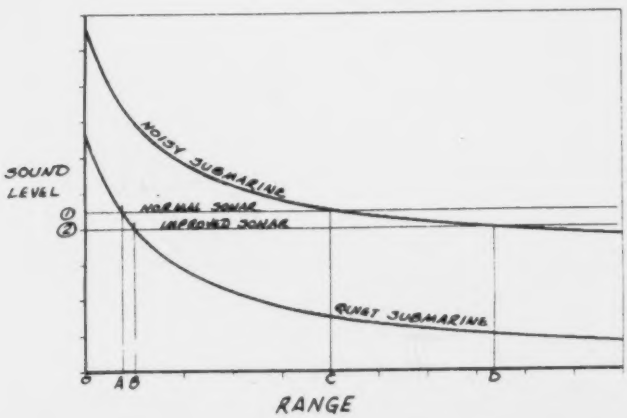
The traditional non-nuclear submarine, with diesel-electric propulsion,

can be extremely quiet when running submerged on its batteries, but can neither stay submerged for long nor move very fast. However, new forms of non-nuclear propulsion -- closed-cycle diesels, Stirling engines, fuel cells, etc. -- are showing the potential for vastly greater submerged endurance than a conventional diesel-electric boat, while retaining its low acoustic signature, and still at a fraction of the cost of a nuclear submarine.

Being the product of foreign technology, such submarines could well become available to third-world nations in the next decade. That is a matter of special concern in that our carrier battle groups often operate near -- and from time to time in the recent past, even against -- such nations. That raises the possibility of small but radical powers being able to threaten the capital ships of the U.S. Navy. And beyond that sort of contingency, the prospect of even one such stealthy submarine under, for example, the Libyan flag entering New York harbor undetected and carrying out its mission is a matter of grave concern.

Thus with the advent of quiet Soviet nuclear submarines and the prospect of even quieter non-nuclear submarines with considerable submerged endurance but of indeterminate nationality, the effectiveness of the passive sonar systems on which we have come to rely so heavily is now being threatened. Thus we are beginning to lose the traditional mainstay of our ASW capability.

The following schematic graph, plotting the level of the sound of a submarine versus its range from our passive sonar, illustrates the underlying problem:




The two curves show how the sound of the submarine becomes fainter as it radiates out through the ocean. The upper curve ("noisy submarine") represents the kind of Soviet submarine the Navy has been dealing with in the past; the lower curve ("quiet submarine"), what it will have to deal with in the future.

Both curves are steep at short ranges because, in simplest terms, the

sound, expanding spherically through the ocean, diminishes with the square of distance (doubling the distance cuts the sound by a factor of four). The curves flatten out, however, when the sound, having reached the ocean bottom, thereafter expands cylindrically rather than spherically, and thus diminishes directly with distance rather than by its square (doubling the distance cuts the sound by a factor of only two rather than four).

The horizontal lines drawn across the graph represent the faintest sounds that can still be detected by two passive sonars, one labeled "normal" and the other, which can detect somewhat fainter signals, "improved".

The sound emitted by the noisy submarine, after starting high on the graph, falls away until, at the range labeled "C" on the graph, it can still just be detected by the "normal" sonar. The "improved" sonar, on the other hand, can still detect the noisy submarine much farther away -- all the way out to the range labeled "D".

The noise emitted by the quiet submarine starts much lower on the graph, and quickly drops to the faintest levels that can be heard by either of the two passive sonars: at range "A" for the normal sonar and range "B" -- not much farther out -- for the improved sonar.

The characteristic shape of the curves -- initially steep, but flattening out with increasing distance from the submarine -- leads to two critically important conclusions:

- By quieting their submarines, the Soviets are drastically reducing the detection range of our passive sonars: on the graph, from "C" back to "A", or from "D" back to "B". By so doing, they are vastly increasing the number of passive sonars that we would need to cover the same amount of ocean (a 10:1 reduction in range would require a hundred-fold increase in sheer numbers of sonars for equivalent coverage).

- Better passive sonars are not the answer. As can be seen from the graph, though the "Improved Sonar" does have a much greater range than the "Normal Sonar" against the old noisy submarine (on the graph, "D" instead of "C"), because of the steepness of the curve at short ranges, there's very little difference against the new quiet submarine ("B" instead of "A"). The improvement in sonar sensitivity that would be needed to restore the detection range to what it was against noisy submarines is simply not in the cards.

Our best current ASW systems all rely heavily on passive sonar: SOSUS (Sound System for Underwater Surveillance -- a network of large, fixed arrays on the ocean floor), SURTASS (Surveillance Towed Array Sonar System -- long arrays towed by surface ships), hull-mounted or towed sonar used on surface warships and submarines, and expendable buoys used on aircraft.

Thus, the loss in effectiveness of passive sonar due to the quieting of Soviet submarines will affect virtually every phase of our ASW capability. And a loss of ASW effectiveness raises profound national security problems such as

our ability to reinforce Europe by sea in time of war, the survivability of our carrier task forces, and our ability to secure our coasts from missile-firing submarines. Furthermore, because many of those wartime problems stem from capabilities that are demonstrable in peacetime, they present opportunities for Soviet coercion. That being the case, alternatives to passive sonar, at least as we have used it in the past, have now become a matter of profound importance.

Dealing With the Coming Decline in Passive Sonar

One alternative to passive sonar as we have known it -- a limited number of relatively long-ranged passive sensors -- is a larger number of short-ranged passive sensors in a closely spaced network. While such systems could be useful at chokepoints such as straits that Soviet submarines would have to transit before they could threaten us, the number of sensors required to cover the open oceans would be prohibitively costly.

The most extensively used adjunct to passive sonar has been active sonar, known prior to WWII as "ASDIC". Instead of listening for sounds emitted by the target submarine, active sonar generates its own pulses of sound and listens for their echoes reflected back from the target submarine. Thus, it -- unlike passive sonar -- can measure the distance and closing speed of the target. But its range has been much less than passive sonar's, at least against noisy Soviet submarines. And, unlike passive sonar, its loud "pings" alert the hunted to the presence of the hunter. Nonetheless, because it is not affected by Soviet quieting, active sonar is receiving new-found attention.

Non-acoustic techniques are also possible. One long in use has been Magnetic Anomaly Detection, or "MAD", in which a sensitive magnetometer, usually carried by an aircraft, detects the very slight distortion of the Earth's magnetic field caused by the steel hull of a submarine. Its range, however, is so limited -- only a fraction of a mile -- that MAD is, and is likely to continue to be, useful only for the final localization and confirmation of a contact made by other means.

Many other non-acoustic techniques are at least theoretically possible. Both the United States and the Soviet Union are exploring such alternatives or adjuncts to passive sonar. It is far too early to judge the success of these efforts, particularly because much of this work is pressing the outer limits of science and technology -- from an understanding of the underlying physics of the various phenomena, all the way to highly advanced sensors and data processing equipment and techniques. Apart from the Strategic Defense Initiative, this work is probably the greatest technological challenge facing the Department of Defense.

The Navy's Reaction to the Coming Change

The introduction of quiet Soviet submarines could well lead to a fundamental change for us in naval warfare. Unless ways to compensate for the coming degradation in passive sonar can be found:

- Our attack submarines are likely to lose much of their effectiveness in what has been one of their major missions -- operations against Soviet submarines;

- Because they will be so much harder to defend against, Soviet attack submarines are likely to become far more effective in operations against our surface ships, both naval and merchant; and

- Deprived of cuing, both our surface warships and our aircraft could have great difficulty in open-ocean ASW.

As noted above, these developments -- which seem likely in the absence of adequate replacements for our traditional passive sonar systems -- threaten the survivability of our carrier task forces, our ability to deploy and support our military forces overseas, and the security of our coasts against submarine-launched missiles. The Panel believes that while the Navy appreciates the gravity of these developments, the scale of its reaction to date does not seem commensurate with the scale of the coming challenge.

We do not mean to imply that the Navy has totally failed to react to these developments. Indeed, it has a number of programs under way. Rather, it is both the scale of the new initiatives and the Navy's management of change that troubles us. The Navy's planning, programming, and budgeting system has long been dominated by so-called "platform sponsors" representing the Navy's three major components: the three-star Assistant Chiefs of Naval Operations for Undersea, Surface, and Air Warfare. We believe that each of these components, concerned as to how the coming changes in naval warfare might affect their own interests, has been reluctant to endorse possibly expensive new initiatives, and has instead tended toward conservatism and the *status quo*.

These narrower, more parochial interests are supposed to have been -- and, no doubt, to some extent have been -- tempered by offices of equal rank but with a broader scope of responsibility: the Deputy Chiefs of Naval Operations (DCNOs) for Naval Warfare and for Navy Program Planning. Nonetheless, the Defense Science Board found last December that the organization was not up to the task of coping with changes of the magnitude now in prospect.

The Panel concurs with the Defense Science Board's conclusion that the Navy's organization has inhibited appropriate action to deal with the immensely important challenges of the future. We, too, believe that some form of organizational change is essential.

The chief characteristic of the necessary change should be a realignment of authority over the Navy program and budget. By "authority" we do not mean any cosmetic reconfiguration of the Navy's organization chart; we mean the political power that actually shapes the Navy program and budget, no matter how the organization chart happens to be drawn at the moment.

That authority must not be the captive of the platform sponsors. It should be able to reallocate in the Navy's annual request as much funding as is necessary to ensure that the effort devoted to coping with the coming change in

naval warfare is at a scale appropriate to the immense significance of that change. That, in turn, implies control over the Navy's recommended allocation of funding among R&D, procurement, operations, and personnel, and, implicitly, control over a major part of the future force structure of the Navy.

The change need not necessarily be *de jure*; an equally satisfactory and probably quicker solution would be a *de facto* "reorganization" in which a) the dominance that the platform sponsors have so long exerted over the allocation of Navy funding were suppressed, and b) the DCNOs for Naval Warfare and for Navy Program Planning, the Chief of Naval Operations, and the Navy Secretariat were able to shape a program commensurate to the looming problem.

After months of struggling with the issue raised by the DSB, the Navy leadership has proposed a plan for reorganization. Though it would create a "czar" to manage the Navy's ASW R&D efforts, the position will be only at the two-star level and thus still inferior to the dominant platform sponsors. We cannot tell at this point what effect, if any, this reorganization will have, but it seems at first glance to be embroidering the organization chart rather than attacking the root problem of why the Navy's most serious challenge is of a lower priority than business-as-usual issues such as force structure.

We believe that the Congress can and should measure the success of this organizational change by two criteria:

- Whether subsequent changes in the allocation of the Navy budget duly reflect the importance of the challenge of quiet Soviet submarines, and
- Whether the architecture of the R&D program represents a comprehensive new approach based on a credible strategy with specific objectives, plans, and programs to deal with the problem, or whether it representes only a continuation of business as usual.

The first criterion above -- improved funding -- is a necessary but not sufficient condition for success. We believe that the second criterion -- a wholly new architecture for our research and development program -- must also be met if we are to be successful in coping with the challenge. Such an architecture must define a rational and coordinated approach to the problem as a whole, defining responsibilities, funding, and schedules. All the diverse efforts in ASW must be integrated into one logical and efficient program that will lead in a fast-paced but orderly way from research to development to the delivery of a new ASW capability before the Soviets build enough quiet new submarines to defeat our existing ASW forces.

We therefore recommend that the Congress closely monitor the product of the reorganization of ASW responsibilities within the Navy in terms of 1) changes in the Navy budget and program and 2) development of a new architecture for a comprehensive program to deal with the challenge of quiet Soviet submarines.

DIVERSITY OF RESEARCH AND DEVELOPMENT ORGANIZATIONS

As noted above, much of the effort to develop new submarine detection systems to compensate for the degradation in passive sonar is pressing our current limits of science and technology. Furthermore, much of the effort to expand those limits is also highly classified, thus raising a problem regarding a critical element of all proper scientific investigation: publication, peer review, and replication of experimental results.

Though there is no evidence that it has happened in this instance, we believe that such circumstances can lead to problems of overcommitment to certain avenues of exploration to the neglect of others, overconfidence in their merit, and insufficiently disinterested interpretation of test results. We believe that the best insurance against such risks is a diversity of research and development organizations.

Such diversity in the form of two major undersea warfare research efforts outside the Navy has already been established by direction of the Congress. One of these is at the Defense Advanced Research Projects Agency, the other at the Central Intelligence Agency. Because the ultimate responsibility for ASW must remain with the Navy, however, these independent activities must be considered as supplements to, and not replacements for, the Navy's own ASW R&D program.

The principal value of such independent research is realized only when it differs with and challenges the Navy's own research on valid grounds. But the independent investigators' willingness to play such a role depends on their reasonable confidence in their own job security. To the extent that they fear that the Congress might allow their funding to lapse, they may be less than enthusiastic about taking prominently independent positions that might alienate the Navy, their most likely alternative employer in this highly specialized field. Thus, if the Congress endorses the concept of independent research, as we do, we recommend that it indicate a strong commitment to continued funding in the future, subject of course to reasonable performance.

The participation of the CIA in a program not only of intelligence, but also of basic ASW research and experimentation merits additional comment. A more intimate understanding of the relevant physics is clearly of value in targeting and interpreting intelligence on Soviet activities. And the quality of the Agency's research is a tribute to the individuals who have managed it. Nonetheless, it is true that running a program of basic research and experimentation is a marked departure from the Agency's traditional pursuits.

To carry out its intelligence responsibilities, we believe that the CIA must maintain a high degree of technical expertise in undersea warfare. But rather than conducting its own independent program of basic research and experimentation as it now does, it should instead have access to and draw on the research of others, and participate in the planning and analysis of that research. Such an arrangement would enhance the Agency's ability to evaluate the gamut of research projects and benefit from the best, as well as eliminating the natural tendency to favor, even unconsciously, one's own research over that of others.

But we also believe that none of its current basic research program should be transferred away from the CIA until a suitable independent organization is found, not only to continue the work, but also to be available to respond to any basic research needs of the CIA that are not being met elsewhere in the community. And in any event, this transition should be a gradual one, carried out over the space of several years with due consideration to the issue noted above: the morale and confidence -- and thus the independence -- of the scientists involved.

A STANDING COMMITTEE ON ASW

Because:

- o Even though the Navy obviously bears the prime responsibility for solving the problem posed by the introduction of quiet Soviet nuclear submarines (and potentially advanced forms of non-nuclear submarines), there is such a diversity of technical and intelligence organizations that can and should contribute to the effort, and
- o The challenge of finding that solution is so formidable, and
- o Success in this effort is of such importance to the national security,

we believe that it would be prudent for the Secretary of Defense to appoint a broadly based standing committee of recognized and, to the degree feasible, disinterested experts in the relevant disciplines to advise him on the subject of ASW -- technology, operations, intelligence, and ASW's role in national security policy. The members should have access to the full range of projects in the field, regardless of classification, uniquely suiting them to develop a broad overview of the effort as a whole. The committee's role would be solely advisory, its only power being that of persuasion. Among the issues it would address would be:

- o The evolution of the submarine threat;
- o Objectives, strategy, plans, and programs to deal with that threat;
- o The adequacy of U.S. programs, management, and resources;
- o The quality of U.S. research;
- o The adequacy of coordination among the organizations involved; and
- o Actions and initiatives that the Secretary of Defense should undertake with regard to ASW.

We therefore recommend a program of research and development on ASW technology with the following characteristics (many of which parallel those we have recommended above with reference to advanced submarine technology):

1) Research on ASW technology should continue in both the Navy and DARPA, independent in approach, but coordinated in planning. Because the consequences of failing to find a solution to the challenge presented by quiet Soviet submarines are so serious, we recommend that this work should be

considered as one of, if not the, highest priority activities in the DoD.

2) Given such a priority and the precedence that finding long-term solutions should take over near-term considerations such as readiness or additions to force structure, the funding for both programs should be determined principally on grounds of what could usefully and efficiently be applied to the task. Both programs thus merit significant real growth in funding but, as with the submarine technology programs, on a predictable, enduring, and stable long-term basis.

3) The CIA should continue to develop its expertise in the technology of undersea warfare, maintain its ability to independently evaluate U.S. research, and participate in the planning and analysis of U.S. research that could resolve intelligence issues. But the Agency should, on a gradual and orderly basis, phase out of independent basic research and experimentation. The transition should be timed such that a host agency, as independent from but coordinated with the Navy as the CIA has been, can be phased in to continue the basic research now under the CIA with a minimum of turbulence, and be available to the CIA thereafter to conduct cooperative research to address intelligence issues.

In addition, we recommend that the Secretary of Defense appoint a standing committee of experts distinguished in the fields relevant to ASW to advise him on the subject.



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Mr. BENNETT. That is an agreeable method to do it. Before we begin, however, I would like to ask if there is any other panel member who would like to share his or her view on any aspect that might seem appropriate. So I will just turn to you first, Dr. Smith.

I would like to see if somebody else has something that I can start with, because otherwise, we might not ask the questions which elicited the things that we would like to have you say.

## STATEMENT OF HAROLD P. SMITH, JR., PRESIDENT, THE PALMER, SMITH CORPORATION

Dr. SMITH. Mr. Chairman, I would like to respond to your request and to note how appreciative I am, and I speak for my colleagues, for the opportunity to have looked into this very serious problem.

I also, from time to time, have had the pleasure of working with Dr. Perry and I realize full well the dangers of trying to improve on anything that he has said. But nonetheless, I will take you at your charge and try to make one point that I think is key and that I would like to emphasize.

The context in which Dr. Perry has been speaking, and indeed, the way we began our investigation, was submarine versus submarine. That is not the key issue. The key issue is submarine versus surface ships. The point here is that the quiet Soviet submarines—and perhaps more importantly, very quiet submarines of other nations—thanks to new technologies allowing very quiet non-nuclear submarines to be built—could conceivably approach much closer and much more dangerously to convoys that might be carrying needed war materiel to wherever the United States is engaged in hostilities.

So the magnitude of this problem, the importance of this problem is the reason that Dr. Perry has noted that increased investments, despite a declining budget, is so important. It is not an issue of are our submarines as quiet or as good as theirs? That is an important question, but the key point is is our ASW capability, our anti-submarine warfare capability, good enough to maintain and protect the convoy of war materiel or just the positioning of power off whatever literals are important in the display of U.S. capability?

I want to emphasize that aspect even more than Dr. Perry did.

Thank you very much, Mr. Chairman.

Mr. BENNETT. Dr. Wood.

## STATEMENT OF LOWELL WOOD, SPECIAL STUDIES PROGRAM LEADER, LAWRENCE LIVERMORE NATIONAL LABS

Dr. WOOD. Thank you very much, Mr. Chairman.

I would also like to express my appreciation to the committee for the opportunity to serve on this panel and I would like, at the same time, to express what I am sure is the appreciation of my colleagues, as well as myself, for the extraordinary support and cooperation which our group enjoyed, not only from the senior membership, but the senior professional staff members of the committee, and in particular, that of Mr. Russ Murray.

With respect to the commentary on the report which we have laid in front of you, I would like to underscore three areas which Secretary Perry referred to in his summary remarks.

First of all is the truly extraordinary capability, capability which it is not possible to speak of in open session in any quantitative respects, but really, as Secretary Perry said, a capability which represented a jewel in the crown of U.S. technological capabilities along military lines, which has been represented for several decades by the passive acoustic anti-submarine warfare capabilities of this country.

That capability, as Dr. Perry pointed out, is dwindling slowly, but steadily, and its loss presently appears to be inexorable.

To cope with the loss of this truly extraordinary capability will require certainly the support, very possibly the encouragement and, I don't think that is going too far to say the insistence of the Congress. Large institutions such as the Navy, and this, of course, is not restricted to the Navy, but all large institutions tend to have perceptual lags. They see things as they have been, rather than possibly as they are or as they will be.

Because of this, the Navy has not moved exceedingly swiftly to deal with the difficulties that will face it at the end of the century with respect to anti-submarine warfare. It is easy to change labels and organization charts and names and budget categories. It is much more difficult to change substance. That is to say, how funds provided by the Congress are actually spent; how the real honest-to-goodness structure in contrast to the parent structure of large institutions such as the Navy actually are.

It is done only with great difficulty and with diligence and determination on the part of everyone concerned. Very frankly, the leadership of the U.S. Navy necessarily turns over quite a bit more rapidly than the time scales on which these problems must be steadily and diligently addressed.

The senior leadership of the Congress, on the other hand, changes on the pertinent time scales. Therefore, it is not only appropriate, but frankly, I believe it is necessary that the country look to the Congress to guide, to supervise, and as necessary, to insist on necessary changes to which Secretary Perry alluded.

Thank you.

Mr. BENNETT. Thank you.

Dr. Kaminski.

## STATEMENT OF PAUL KAMINSKI, PRESIDENT, H&Q TECHNOLOGY PARTNERS, INC.

Dr. KAMINSKI. Thank you. I, too, would like to express my appreciation to my fellow panel members and to the committee staff. I would like to recognize in particular, Russ Murray, who played a critical role in gathering together and obtaining consensus views of the panel.

There are four points I would like to make. The first two are in terms of trends. As we look at our operational anti-submarine warfare capability today, we are near a crest in capability. Our operational capability has never been better. We have effectively worked out the bugs and the performance problems of the various

sub-systems, the component contributors to our ASW capability that were developed in the 1970s. Those are now in the field and working well together as an integrated system.

We have a very strong and solid capability in the field today operationally. The problem is the certain demise of that system as newer, quieter Soviet submarines are deployed. That isn't going to happen overnight; it is going to happen over a period of time.

So we can see that crest in our capability today and we can forecast its demise in the future, knowing that we have some time to do something about it.

My next two points deal with the solution to the problem.

First, we need a stable, long-term research and development base to develop the components of the solution, recognizing that no one sensor subsystems is going to do the entire job. We are going to need several sensor subsystems put together to deal with this serious problem. Second, we are going to need an architecture and an architect to bring it about, to make it happen operationally.

Having the research base, having the sensor technology by itself isn't going to do the job, so we are going to need leadership and an operational perspective to bring this all together to field again an effective system.

Mr. BENNETT. Architecture has been used twice in this, and I am not sure it is being used in a way in which I understand it. You are not talking about the architecture of building a particular submarine, are you? Is architecture being used in another way?

What do you mean?

Dr. KAMINSKI. Mr. Bennett, if I were to use the building analogy here, the various sensors and the components that we may be developing in our R&D program, you might think of doors, windows and cornerstones for a building.

Mr. BENNETT. They are not tied together yet; is that what you are saying?

Dr. KAMINSKI. They are not tied together yet.

Mr. BENNETT. Is that a big problem?

Dr. KAMINSKI. It is a very significant problem, a system integration problem, and an operational problem of bringing all of these elements together. We are not talking only about sensors that may go on submarines. These may be off-board sensors; they may be fixed; they may be on other platforms. We have the job of knitting this all together into a system that works operationally.

That may be as big a challenge as developing the sensors themselves.

Mr. BENNETT. I didn't mean to cut you off. I was just trying to understand it.

Architecture doesn't mean the building of a particular ship; it means an atmosphere or an organization under which ASW is attacked as an ongoing, permanent thing that has to bring all these R&D things together.

Dr. KAMINSKI. Exactly.

Mr. BENNETT. You don't think that is really being done right now.

Dr. KAMINSKI. Such an architecture has been developed to support our present ASW system. The problem is we need to do it again over a period of time.

Mr. BENNETT. All right.
Dr. Rosenbaum.

## STATEMENT OF HAROLD ROSENBAUM, PRESIDENT, HAROLD ROSENBAUM ASSOCIATES, INC.

Dr. ROSENBAUM. Thank you, Mr. Chairman. I too would like to thank my fellow panel members for their efforts.

I have a few comments I would like to make. I think that as you consider the remarks being made here concerning what we claim is being done and what we claim is not being done or should be done differently, you should bear in mind that, to a large extent, our committee of "experts" represents an R&D community. On research and development people, we have the luxury of looking far ahead. The Navy or any other acquisition community generally doesn't have quite the same luxury. I wish you would bear that in mind when you hear us say, "Gee, we wish the Navy were moving faster," or comments to that effect.

That is not to say that the luxury of looking far ahead is not rapidly disappearing, as you heard from Dr. Perry. While we do have time, we no longer have excess time. The threat is becoming severe and we believe that—to echo Dr. Smith's comments—we cannot, as a Nation, and as a member of the western community, afford a parity in submarine and anti submarine capabilities for the very simple reason that the West has most of the targets that submarines are very effective against.

To the extent that the United States and its allies depend upon the shipping lanes to keep their alliance together; to the extent that we in the U.S. have large coastlines that we must defend; we can't accept the prospect of adversary submarines that are so quiet and so good that we can't stop them.That is why we believe the question of are our submarines as good as their submarines is not the most relevant question. The most relevant question is: can we protect the assets which the West holds very dear against the threat of Soviet and third-country submarines? I would just like to re-emphasize that as being the key issue.

In reviewing anti submarine efforts that were presented to us, I can report that I have seen no magic solutions. I have seen nothing over the horizon that would render the oceans transparent. I have seen a number of good ideas that really deserve additional work and additional attention and that is one of the important changes I would like to leave with you.

We feel now is the time to focus and fund an aggressive program to seek solutions to the submarine threat.

Thank you.
Mr. BENNETT. Thank you.
Admiral Jackson.

## STATEMENT OF HARRY JACKSON, NAVAL ARCHITECT

Mr. JACKSON. I also want to thank the committee for the opportunity to work with a group of people who I consider to be outstanding in their own field.

In regard to the discussion a few minutes ago on architecture, the sensor business is changing so much that it is going to have a

tremendous impact on the configuration of the submarines of the future. It is quite probable that the submarines of the year 2025 will be vastly different from the ones we know today. It will be driven primarily by the need to incorporate the new sensors in the basic fundamental design of the submarine.

One other point I would like to make is that all the research in the world will be of no use unless there is an opportunity to put it into service. Downstream, that means authorization of new classes of submarines on a rather continuous basis.

I think we no longer can afford the luxury of running a 20-year program with the same submarine. They are going to have to be changed frequently.

Thank you very much for the opportunity to be here.

Mr. BENNETT. We are certainly very grateful for each one of you for your participation and your collegial efforts.

What is the panel's views on proceeding with the SSN–21 submarine according to schedule in the current budget proposal; that is, two ships in 1991 and three per year thereafter?

Have you given thought to the procedure about how fast we ought to operate on the 21? What do you think about a schedule on that, Dr. Perry?

Dr. PERRY. We didn't undertake a programmatic review of the SSN–21, Mr. Chairman. We did form an opinion that going to a new-generation submarine is an important part of the U.S. submarine/ASW capability, and that the SSN–21 appears to be an appropriately designed submarine for doing that.

If any of my other panel members want to comment further on that, they are welcome to.

Mr. BENNETT. Dr. Wood?

Dr. WOOD. Mr. Chairman, to comment on that indirectly, what the panel did look into extensively was the outlook of the likelihood of substantial benefit deriving from regularly produced research submarines. That is to say, systems or ships that would probably be one-of-a-kind vehicles which would explore everything from new technologies in propulsion and structure to new technologies in sensor and weapons systems.

The panel, in its report, did note that enormous benefits had derived from U.S. practices in the 1950s along these lines and regretted that these practices didn't continue through the present time. So the thing which we—the issue that we can speak to specifically is the great desirability of research submarines being laid down on a regular basis to explore new technologies and how these technologies might play in an operational context.

Mr. BENNETT. In the past, we have more or less focused on submarine hull, mechanical, electrical systems and things of that type. Does any member of the panel have a feeling about whether we should change that emphasis? Is there a need for a change? Dr. Rosenbaum?

Dr. ROSENBAUM. Yes, I think there is. There are enormous benefits that a submarine as stealth platform can bring to bear in warfighting. Those benefits can be significantly increased if the submarine can make use of off-board systems. That is, if something offboard the submarine can help detect the target and the submarine can become a marvelous force multiplier weapon.

By simply concentrating on the hull and machinery and electrical parts you limit the utility of the submarine system by limiting the development of a true architecture, Mr. Chairman, an architecture that incorporates other assets into a warfighting system of which the submarine is but one part.

So I do feel that off-board sensors and better weapons, perhaps off-board, are really a necessary part of a submarine architecture.

Mr. BENNETT. I appreciate the comments that were made by one of the panelists with regard to the fact that sometimes if you are a long-time servant here, as a Congressman, you do have a perspective which is a little different from people who come and go within the Navy.

There is an obvious reluctance on the part of some of us who are not really sailors, not really admirals and so forth, or admirals, to stick our necks out on this, but since everybody wants to have the Government have as strong a defense as possible, perhaps that could be overlooked at times. We have problems with regard to the 21, for instance. Some people want to wait and produce a 21 another decade from now. I guess the thrust of your panel is that maybe we are not going fast enough to some type of limited production.

That seems to be what you would like to do—to not wait for a decade or so to produce a new submarine, but rather produce at least portions of the submarines? Does anyone want to address that?

Dr. PERRY. I will comment on that, and I think some of the other panel members would like to as well.

We believe the R&D program should be more aggressive. We believe it should proceed rapidly into building prototypes and testing at sea. We believe there should be a greater emphasis on formulating this architecture, the description of the entire network of systems which is necessary, and that with these things being done, we could move toward a fielded system and an earlier date.

Dr. SMITH. Mr. Bennett, I would like to respond to your question.

I am worried about your question because it seems to emphasize a continuing flow of modern submarines year after year; whereas I think the problem is this word that you correctly challenged, architecture.

I think I speak for my colleagues in saying that we did not find, in fairly extensive meetings with considerable probing, the sense of prioritization within the Navy to bring to your attention the right programs, recommending to you what should be done first and for how much.

In other words, you hire your architect to lay the plans for how to proceed. We found no such architecture. We, being intelligent men, tried to understand why and I think it is really two-fold. In an era of declining budgets, every member at high level in the Navy knows that if prioritization of various projects are undertaken, those that are not at the top are canceled, and yet, the Navy, as is well known, is not the Navy, but the navies. There are at least three major platform houses in the Navy and each of those have their own needs and desires. Therefore, to try to establish a prioritization where programs will get cut if they are prioritized in a house that has three masters is very difficult.

I think that is one of the reasons that Dr. Wood brought to your attention the need for some kind of congressional longevity and viewpoint.

The second impediment to building this architecture which we have called for is the extensive compartmentalization. It is very difficult for me as a scientist, who has looked at some of these programs, to say that they should not be held in greatest secrecy. Some excellent work has been done and is being done, work that we would not like to read about in the press. There is a need for compartmentalization. In my opinion, and I think that of my colleagues, it impedes that ability to plan where we should spend our money, what we should do first.

There are agencies other than the Navy involved here. The report tells you flatly, in the summary, the CIA is doing some extraordinary things for the agency and, in my opinion, is doing them very well.

We have DARPA, Defense Advance Research Projects Agency, also participating with—as far as we can tell—with the blessing of the Navy. DARPA and the Navy appear to be working very well, but it is absolutely critical that we have an agency whose charter is to take on the high risk, high payoff research that the Navy, with more operational responsibilities, cannot and maybe should not do, but there is a great need for an architecture, plan, who does what, an establishment of priorities. What is high risk? What is high payoff?

We are not finding that necessary ingredient, and there is a corollary that goes with that. If we, the United States, or you, the Congress, are going to call upon agencies like DARPA or like the CIA to carry out programs that really are the Navy's responsibility to implement, if not to develop, but to implement, then there must be continuity that once begun, assuming good performance, we must maintain a reasonable funding level at these other agencies to ensure that we can recruit and retain the kind of people necessary to do the kind of work that the magnitude of this problem calls for.

So I am afraid, once again, sir, I have given you yet another opinion of what the word "architecture" means.

Mr. BENNETT. I think it has been helpful. You seem to be calling for a second coming of Mr. Rickover.

Dr. SMITH. That is unfair, Mr. Chairman.

[Laughter.]

Mr. BENNETT. I hope not.

Dr. WOOD. But it is not terribly wide of the mark, Mr. Chairman.

Mr. BENNETT. Mr. Dickinson.

Mr. DICKINSON. I want to thank all of you gentlemen for giving of your time and expertise and valuable experience and insight into the problems.

I think, if nothing else, the good that flows from your collective efforts would be to highlight and to help us focus on what the problems are because we do recognize that there are problems that need to be addressed.

One of the problems is making sure that the Navy itself is onboard and has taken the lead in the effort and is supportive of

what you would recognize, and no doubt we will recognize as the most important job in the ASW field.

As Dr. Smith has pointed out, we really have three navies and the submariners don't always agree with the other surface Navy and the airplane drivers don't necessarily agree with the submariners as to what the needs are. So, really, that is the reason we are supposed to have a Secretary of the Navy and a CNO to bring this divergent opinions together and focus on what is best for the total Navy.

We find that this really hasn't been all that effective in the past and we have found that the Congress has really reluctantly been thrust into the role quite often of making decisions that should be technical in nature and should be decided within the Navy, but they haven't done it.

For instance, it has been this committee that has put the funding in for the advanced ASW for the past couple of years at least. It hasn't been the Navy taking the lead in this thing. I think, as a result of your work and follow up from this committee, we will be beating on the Navy to get out front and do something—make a decision. They should be leading us; we shouldn't be leading them, but it just hasn't worked out that way.

There is not money in this budget, as I understand it. I probably shouldn't be asking you; I should be asking the Navy, but I will ask the staff to comment on it. Is there anything in this budget that would emphasize and delineate or be a line item to move out in the ASW field or is it just all lumped in together?

Mr. MURRAY. There is an increase in the funding for ASW research over the next 2 years. Unfortunately, after that, the funding decreases, not only in absolute terms, but in a percentage of the total Navy R&D budget, which is very hard to understand.

It looks to us as if the Navy is doing something in the short term, but does not have a long-term plan for attacking this problem.

Mr. DICKINSON. That is different from what it has been for the past couple of years, is it not?

Mr. MURRAY. I believe that is right.

Mr. DICKINSON. So you help us identify the problem and make some suggestions as to which direction it should take and we have to come to the conclusion and hope, then, that we can agree with the Navy or at least insist that the Navy move out on the problem because I think you are exactly right in that this, coupled with the ASAT problem—and I think it was Dr. Rosenbaum who spoke about this—really has a synergistic effect that permeates the entire Navy and naval capability that we have.

If they have the capability to deny us what we can see by looking down, and they do, and we don't have a countercapability, and they have the ability now to evade our ASW capabilities on the surface and subsurface, or an increasing capability, then we find ourselves more and more at risk and more and more less able to meet the threat.

Dr. Rosenbaum also mentioned off-board capabilities being transferred to give the capability to the submerged sub, which again gets back to communication and how can this be communicated

from some other form—either from the air down or through the water to communicate to the sub the additional information.

It all has to come together and I would hope that we would not only move out on it together but I would hope that the Navy would also take the lead.

I really have no more questions, Mr. Chairman. I thank you for the opportunity, and I yield back.

Mr. BENNETT. Mr. Spence.

Mr. SPENCE. Thank you, Mr. Chairman. Thank you, gentlemen, for coming this morning. You have obviously done your homework. You have done a lot of good work for us and we appreciate it.

I was mainly concerned, looking over the work that you have done about your summary, when you talked about the starting-over business, that leaves a whole big field out there. I didn't know exactly what you meant about where you were going to start over.

For instance, we have been told and led to believe, and I think with some justification, that our new follow-on submarine, the SSN-21, is state of the art technology for now and the foreseeable future. We put into this submarine all the advances and technology that we have been able to come up with and foresee. Realizing that we are in a fast-changing world from a technological standpoint, can you recommend anything we should do from the standpoint of the design of the SSN-21 or any listening devices or anything else that can be done that would upgrade this submarine?

Mr. JACKSON. I will attempt to answer that.

In the first place, the SSN-21 is a very fine submarine and we ought to get on with the building of it just as quickly as we can. It should proceed into the fleet at the earliest possible date so that we can truly assess its capability.

But as you pointed out, technology is changing and it is changing at a very rapid pace. We have the opportunity of saying, "Well, we will incorporate the new technology in later versions of the SSN-21," and that is one course of action.

Another course of action is to start immediately on the design of the next flight of submarines. The SSN-21 really originated in early studies almost 12 years ago. If it takes that long to get the next flight, there will be many SSN-21s at sea by the time we get our next flight ready.

The option of making alterations to the later SSN-21s will remain with us forever. That is always there. So there is no hazard in starting the new design immediately.

There are many items of technology that are now on the horizon that will vastly improve the submarines of the future. We should take advantage of the opportunity to incorporate those new things at the earliest date.

There has been some debate in my mind whether it is more economical to make a long run of essentially the same submarine in which you modify it to incorporate new technology versus making shorter runs of new submarines. You can go either way.

In the past, we have really tended to make shorter runs of more submarines, and when we did that, there was no question that we were leaders of the submarine technology. Because I was concerned about this, I have a graduate student making a thesis to study the

economics of long runs of submarines versus short runs of submarines.

I don't know what the conclusions of that will be, but it certainly will provide the basis of extensive debate.

But back to the original question, I strongly recommend that we get on with building the 21 just as quickly as we can.

Thank you.

Mr. SPENCE. Thank you, Mr. Chairman.

Mr. BENNETT. All right. The next person is Sisisky.

Mr. SISISKY. Thank you, Mr. Chairman. I thank all you gentlemen, also, for the work that you have done. I read your report last night and, unfortunately, I didn't bring my copy that I scribbled notes on today that I was going to ask you. Actually, it was a very frightening report and I think the press caught it as a frightening report.

The one thing that bothered me—and I think you aptly stated it when you said there were different navies in there. But I think it goes even further than that. There are three different services in there. The real problem is when we are in tight budget constraints, how do we cut one-third and leave that little amount of money?

I have been to every meeting that the Seapower Subcommittee has had this year. When we talked about submarines and the Navy didn't talk about ASW, I don't remember hearing a meeting that they didn't consider it a real problem. In our executive sessions, they identified where every submarine that they could identify was at. You aptly recorded the Akula, which is the quiet submarine. They only have three. We have 49 very quiet submarines.

But in the three navies, and even with Congress, we worry about the priorities in the Navy.

We had a hearing last week about the priorities of mine warfare. We found in the Persian Gulf, that we had a great deficiency in mine warfare. So what are we doing? We are building ships to do that. We know that we need an upgrade of the Aegis system to make it more palatable in the surface war that we have to fight. Obviously, we are doing something with our airwing of the Navy, new aircraft and—so with all of these things, there is an increase in the ASW budget.

What I am really asking you gentlemen—I do know for the next 2 years there is an increase in ASW—how much of an increase in ASW will there be? I think somebody mentioned it there and I wrote it down—privy to see. How much privy do you need to see what the Navy was doing in ASW?

Dr. PERRY. A good bit of the Navy program was briefed to the entire panel. Some of their R&D programs for advanced sensors, which they considered to be the most sensitive—they limited the briefing on that to two of the panel members, myself and Dr. Foster. As far as I know, the two of us had access to all of the R&D programs they have in ASW.

We did not get briefed in any extensive detail on operational security matters.

Mr. SISISKY. Mr. Chairman, I would like to ask now if this committee—and it would be perfectly all right with me if this panel could sit in—plans on hearing from the Navy with regards to this

report and exactly what they are doing about it. I think this would be a critical thing and really would be something that we could——

Mr. BENNETT. We do plan to have one.

Mr. SISISKY. We could prioritize——

Mr. BENNETT. I think it will be probably sometime in April, mid-April or a little later. The Navy will respond and give us their ideas, particularly on the ideas you have suggested of a dedicated level of personnel that are going to work on this and with the ASW paramount in their view. We would like to have their response in a hearing sometime this spring.

Dr. ROSENBAUM. Mr. Chairman, I would like to emphasize that the last thing any member of this panel wants to do is have this report viewed as one promoting an adversarial position between us as researchers and the Navy as a service.

We don't have the pressures that the Navy has as I said before. We are, for the most part, technologists. We are not involved in building today's systems and meeting today's budgets.

We can advise you, as we have been asked to do, on what we see as the nature of the threat, what we see as an adequate response, and what we think should be done to develop that adequate response. It would be my guess that the Navy probably doesn't disagree at all with some of the things that we have suggested.

When it reaches the point of budget priorities, it goes beyond what we addressed. We did, however, address, and it is worth emphasizing here, some of the aspects of managing and running R&D and technology. To this issue I would like to repeat two of the points that Dr. Smith made.

We found compartmentalization, while probably necessary in this area more than any other area, is basically in tension with the notion of making technological advances and gains. As a technologist, my first inclination is to try to increase the number of people, the number of scientists who are working on a particularly difficult problem. My tendency, when looking at a radar-sensor problem, for example, would be to go to other people in areas of application other than ASW who have performed work on radar sensors and ask them to contribute.

We found compartmentalization was a great inhibitor to this, with the result that the community of investigators was not as large as it should be. We are not training enough new engineers and scientists to apply the necessary talent to this particular problem. That is one problem I found in the technology management of these programs.

The other one was continuity——

Mr. SISISKY. When you say "we," are you talking about the Navy or we as the United States training?

Dr. ROSENBAUM. I can't fault the Navy for applying particular constraints on compartmentalization when security is so important and when there have been so many breaches of security. Rather I think it necessary to have some overseeing function decide where compartmentalization is important, and how we manage our security and still increase the pool of research scientists and engineers working on this problem.

The other problem I found disturbing was the one that Dr. Smith referred to as continuity. There, perhaps the Congress can provide

the biggest help. The problems that we are talking about in ASW are not 2-year problems. There is no magic solution. We see the need for a dedicated, focused, long range R&D program, which can attract the people and the management.

It is impossible to attract good people when budgets are adjusted and readjusted on a yearly basis, either blipped up or blipped down or changed or directed or put into somebody's pet program. It is less than useful to do something like that.

What is useful, and where the Congress can help, is to develop a mindset that the problem is so important that priorities will provide budget continuity and the community is tasked to solve that problem, as opposed to being told what the solution is. Budget continuity and some sort of discretionary ability to change direction within the program as new ideas come about has got to be provided by the Congress in order to have a viable R&D program.

Mr. BENNETT. I would like to make the observation that there are Navy people here who are listening and taking notes—I would like to have somebody come back when the Navy does testify and give me their view. Of course, you can't repeat a personality like Admiral Rickover, but we'd like to repeat the process of having somebody whose career would be dedicated to this sort of achievement, rather than whether he gets another star or whether he stays a certain length of time in the military.

We could, of course, address it by legislation. We did last year in regard to conventional weaponry. We put a provision in the law that said the Department of Defense has to have a group in the Department of Defense which looks at conventional weaponry to see; then report whether we are doing an adequate job and Congress must act upon that report.

That is a way in which we could do it. We could structure it that way. Maybe we will say that the Navy must report to us on whether or not adequate attention is being given to it.

Another way would be if you had someone willing to dedicate the rest of his military career in the Navy without regard as to whether he gets a higher job or not, but just to see to it that we got good ASW. That is a wonderful thing for our country. That is a possibility.

How you find such a person or how the structure of bureaucracy will adjust to it, I am not sure. But it is worth looking at. I would like the Navy to address those questions.

Dr. SMITH. Mr. Chairman, is there time to respond to that?

Mr. BENNETT. Well, I really shouldn't, but you respond anyway. In other words, I am supposed to not take the time. I am stealing from the next guy, so please do it briefly.

Dr. SMITH. First, a quick point, Mr. Sisisky, in no way would this committee want to recommend that ASW not be the purview of the Navy. It is not an Air Force problem; it is not an Army problem.

Mr. Dickinson had said he is worried about what I think we tend to call micromanagement. This panel also worried about just what kind of management can the Congress impose on this problem?

We decided—I think I speak for us all. This is not the right time for us to recommend to you or for you to force upon the Navy detailed management techniques. If the Navy can produce another

Rickover with whom they can work easily, by all means, the Navy should do that.

The important point here is that we have a new Secretary of Defense who comes in with the full backing of the Senate. We are leaving behind an administration where I think more decisions were left to the Secretary of the Navy or the Air Force, depending on what the situation was. No one at this point, even Mr. Cheney, does not know what style he will adopt. But there is a way in the Office of Secretary of Defense and for the Secretary of Defense himself to impose management restrictions or management techniques on any of the services.

The Navy itself has responded, perhaps to some extent because of this panel, by creating what they call a czar of ASW. They only gave him two stars, but your point pertains, Mr. Chairman. The right man with two stars perhaps can do it.

At the very least, we were all impressed by the dedication and intelligence of those Navy officers with whom we dealt. We would not want to tell the Navy—we, this panel, would not want to tell the Navy at this point that their new approach to ASW is wrong, but I should hope that the mere fact that you formed this panel and that we have reported to you in this very formal open way should put the Navy on notice that you are going to be watching them very closely with regard to their management technique and I think it should also tell Mr. Cheney that he will be expected to impose a more architectural view of how ASW should be conducted.

A key subtechnical point there is that the submarine is by no means necessarily the best ASW platform. Do not think that because we have the world's finest submarine—and I agree with my colleague, Mr. Jackson, that we do have in the SSN-21 the world's finest submarine today—do not think that we, therefore, have the best ASW for the future. There are other platforms that, in my mind, and I think the minds of my colleagues, could play a more important role in ASW, anti-submarine warfare, than the submarine itself.

I hope I didn't take up too much time from those who will follow.

Mr. SISISKY. Thank you, Mr. Chairman.

Mr. BENNETT. Mr. Bateman. There were other members here before, Davis, Hunter, Kyl and Darden, but they are not here at the moment, so Mr. Bateman is next. You are recognized.

Mr. BATEMAN. Thank you, Mr. Chairman.

Mr. Chairman, I, too, would like to thank the panel because they have rendered an important service to the committee and to our national security effort.

I guess I am a little bit more sanguine, perhaps, than the panel, though I don't read you as being Chicken Little or panicky. But my perception is that when the United States Navy, after the years of effort to develop the SSN-21, to move the technology as far as that moves it, to get it integrated into a hull and matched with a propulsion system and the degree of confidence that they are ready to build, and finally getting, hopefully in this session, the authorization and funding to go forward with it. It took an enormous pool of talent that spent an inordinate amount of time bringing us to where we could move forward with the production of the SSN-21.

I would hope that our friends in the Navy, and I hope they are listening, would understand that we expect to see much of that pool of technology, talent and management related to where we go from here—beyond SSN–21 and anti-submarine warfare.

Having said that, I was delighted to hear Dr. Smith's comment a moment ago that, to the extent that we perceive there are problems out there that may become egregious in anti-submarine warfare that go beyond our historic reliance upon sound detection systems. Do we sometimes risk being sort of blind-sided when we say anti-submarine warfare? Are you necessarily talking about submarines as the platform for waging anti-submarine warfare?

What are the theoretical, conceptual approaches that can be applied that bring us beyond or enhance the sound detection methodology to different methodologies and what is the best platform? Maybe that is what you all are talking about when you use the word architecture so much this morning, because, quite frankly, it has been a very elusive term. Sometimes it seems very, very narrow and other times it sounds so broad as to be meaningless. I am not sure in which way it is being used in any given instance.

I would like your comments as to whether or not we do perhaps look unduly or excessively at the submarine as the ultimate anti-submarine warfare platform.

Dr. PERRY. I will comment on that and perhaps other panel members would like to as well.

Our present ASW system involves substantially more than submarines. We have hydrophones mounted in submarines, to be sure. We also have them on surface ships. We have them moored to the bottom. We use aircraft, surface ships and submarines all in pursuit of ASW.

What is different about the situation that is emerging is that with the necessity to develop other sensors, with the decline of the hydrophone as the primary sensor in the system, the dependence on these other platforms is going to get very much greater.

Therefore, the system, which is used to conduct ASW, the surface ships, the airplanes, the submarines, the sensors, the communication that ties them all together—let's call it a large system instead of an architecture. That system is going to become more complex and it will be less possible to conduct ASW from a single point, a single platform.

The one thing that we have determined with certainty is that whereas the hydrophone may have been considered the silver bullet of the present system since it all-pervasive in everything we did, there will be no silver bullet in the next system. We will use a variety of sensors and variety of platforms.

Therefore, the dependence on how these platforms are pooled together and interoperate with each other will be much, much greater.

Any other comments on that?

Dr. WOOD. Just to underscore Dr. Perry's point and to respond specifically to yours, Mr. Bateman, the finest SSN in the world, as the SSN–21 will be for a period, cannot kill the Soviet submarine whose location it does not know. The one figure in our report on page 4 shows how extremely challenging that problem is becoming as the Soviets quiet their submarines.

We simply cannot defend our ocean-going assets against Soviet submarine attack if we can't find those submarines and if our only knowledge that they exist or that they are present in an area is when they launch torpedoes at our surface ships.

So it is by no means clear, as my fellow panelists have said, and I would just like to emphasize—it is by no means clear that the single most apt ASW platform at the end of the century or thereafter will be an SSN of any kind. It may well be some combination of other sensors carried on other platforms and other weapon-delivery means.

Mr. BENNETT. Mr. Hutto.

Dr. SMITH. Could I make a very brief comment on Mr. Bateman's——

Mr. BENNETT. Yes.

Dr. SMITH. Sir, you had a very perceptive sentence or question in which you said, "Is anyone looking"—referring to the Navy—"Is anyone looking and is it systematic?"

I think the terse answer to that, perhaps unduly so, is a yes. The Navy is looking and we give them great credit for that. "Is it systematic?" Not as much as it should be, and that is where you correctly recalled this word "architecture." It is the same idea. "Is it systematic?" Not as systematic as it needs to be.

Mr. BENNETT. Mr. Wood.

Dr. WOOD. The building, sir, tends to be gerry-built, rather than constructed according to a master set of plans. That is what this panel is referring to in the use of the term "architecture."

There is no master plan to say how we get from the situation that we are in at the present time to a much more healthy situation a decade or two hence. It is a piece-at-a-time sort of construction and that gives you a gerry-built structure.

Mr. BENNETT. Mr. Hutto.

Mr. HUTTO. Thank you, Mr. Chairman. I, too, would like to add my appreciation for the work the panel has done on this subject. I am sorry I didn't get here for most of your testimony.

I gather that all of you found it rather surprising that the Soviets have made the inroads that they have as far as silencing their submarines. Is that correct?

Has their degree of technology in this area surprised you?

Dr. PERRY. No, it is not surprising. What is surprising is they didn't get there 10 years ago. It is a belated development and even with this development, they are still perhaps 10 years behind the U.S. in this technology. It is not that what they have done was such a technological leap forward; they still have not caught up with the U.S.

But it presents our submarine detection systems with a new and much more difficult problem. The phrase I used before you came in is that we no longer have a free lunch. We now have to work at it to detect the submarines.

Mr. HUTTO. Do you have any idea how much was achieved by the Walker spy ring, the sale by Toshiba? Has either been a big contributing factor in your view?

Dr. PERRY. I don't know the answer to that question, but I will say that what they have done was not a technological tour de force;

it is just a combination of techniques with very careful attention to detail in the design of the submarine.

I think I should refer to Mr. Jackson, who is more of a submarine design expert than I.

Mr. HUTTO. Mr. Jackson.

Mr. JACKSON. Dr. Perry is correct in that this came as no surprise at all. Whether or not they benefited by intelligence on their part is debatable, but it is very easy to believe that they just made a overt decision to make their submarines quiet. They did it in exactly the same way that we did it, by looking at the fundamentals and seeing what has to be done in order to suppress the noise radiation signals from their submarines.

I think that was the majority of the effort that went into quieting their submarines, although they undoubtedly had some help along the way in minor details.

Mr. HUTTO. Am I to understand that you are not really quarreling with the amount of funding in ASW research in the next couple of years. It is just the manner in which we are doing it—the lack of a long-range plan. Is that correct?

I mean, there are increases, as I understand it, at least for the next couple of years.

Dr. SMITH. Dr. Perry, I think, addressed that problem quite accurately before you were able to get here.

There is a need for increased funding in this field, despite a declining budget. Mr. Murray, your counselor, commented on the Navy's request, which is for an increase over the next 2 years, but then a decline. We see no reason why there should be a decline.

Yes, there is additional funding necessary in this field.

Dr. PERRY. Let me make one other point. Precisely because we are having some success in exploratory research in this field that research will be graduated to prototype systems and deployed systems in the years ahead of us. That is going to be much more expensive than the effort done to date.

So we see nothing but substantially increased expenses in this field as the R&D moves from 6.2 to 6.3 to 6.4, each phase of which is going to be more expensive. What we have in hand is the requirement to build and field an entirely new submarine detection system, an entirely new ASW system.

That is going to be very expensive.

Dr. ROSENBAUM. I might add that if John Foster were here, he would say—there are many important ideas that should be pursued that are not being pursued for a lack of funding at the R&D level.

Dr. WOOD. Specifically, the panel found a great deal to praise in the approach to ASW R&D, which is currently ongoing, two of those legs being specifically at the initiative of the Congress. The Navy, of course, has the primary responsibility in this area, but the panel found that their commitment is primarily to evolutionary advance of the ASW capability.

The DARPA approach has relatively high-risk, high-payoff technologies the committee has strongly urged continuation of and the CIA participation in assessing and monitoring Soviet developments, which are often in advance of American developments also was an area that the committee felt should be continued and bolstered.

So we have been speaking to the Navy ASW budget, which, of course, is the largest one. The ones of the other two agencies, DARPA and the CIA, however, this panel found were essential players and strongly urge the committee to support their continued participation.

Mr. HUTTO. All right. Thank you.

Mr. BENNETT. Mr. Hunter.

Mr. HUNTER. Thank you, Mr. Chairman, and gentlemen, thank you for being with us today. I wanted to also give my expression of thanks to the chairman of the full committee because I think this is one of the most important issues we will see in the next several years.

Pardon me for being out during most of your early testimony.

Let me wrap up this thing the way that I see it and ask you for your response. It appears to me that what you are saying in this report is that we need to do some overall prioritizing which may, in fact, infringe upon the surface Navy and the moneys we are spending there may infringe upon interservice—on the Army's expenditures, Air Force expenditures. This isn't just a matter of trying to address this very critical situation by going through business as usual. In fact, I think that term is stated here.

What you just said in paraphrasing what you think Johnny Foster would have said, which I think he probably would have, I think is very true. There are a great many R&D programs we are not pursuing because we don't have the funds that we need.

My question is that understanding Congress, as I am sure most of you do, and the way that we operate, with everyone having his piece of the turf and his piece of the action, as well as the bureaucracy needs to be faced, how do you propose going about a reestablishment of U.S. submarine and ASW superiority?

Maybe Dr. Wood could lead off with that answer, because he is always so creative. Lowell, what do you think?

Dr. WOOD. You are much too kind, Congressman.

It is, I believe, the panel's opinion and pretty clearly expressed in the report, that while additional funding to be put to good use in all three of the navies, the undersea, the surface and the air Navy, that U.S. capabilities are challenged most severely in any of these three areas in the undersea area, and if there is a cap on congressional support which can be extended to the Navy, then the partitions must be moved within the Navy budget in favor of accelerated effort in the ASW area.

Mr. HUNTER. If you are talking in blunt terms, you are talking about surface ship production? In your estimation, is it something in which we should sacrifice that production?

Dr. WOOD. That is nothing which the panel considered, but we did say quite clearly in the report that there must be a greater percentage or, at least in absolute terms, a stiff increase in the level of attention, the level of resources which are devoted to the ASW problem.

Where that comes from, we did not specifically address, but there are obviously only three places it can come from, either the surface Navy, the air Navy or additional resources given to the Navy by the Congress.

Mr. HUNTER. Thank you.

Anybody else want to hammer that one?

Dr. PERRY. I would simply comment that we believe that the development and fielding of the new ASW system is not only a top Navy priority, we would call it a national priority and it should compete with Army and Air Force programs, as well as Navy programs.

The second comment is that while we have advocated a more aggressive R&D program, and while that will cause moderate increases in fundings in the next few years, the major increase in the funding is in the presently unbudgeted expenses of carrying the success of this development into the field. So we have 6.3, 6.4 programs looming ahead of us yet, which have not been budgeted.

So the major budget disconnect is not in the exploratory research which is now going on; it is in the unbudgeted funds for deploying and fielding these systems once the developments are complete. That should be in the relatively near future, 3, 4, 5 years into the future.

Mr. HUNTER. Your last paragraph mentions the recommendation to the SECDEF that he appoint a standing committee of experts, distinguished in the fields relevant to ASW, to advise on the subject. It is obvious that we need some management of this problem.

Is that a kind of organization we could talk about overall prioritization between the services, perhaps?

Dr. PERRY. Anyone want to comment on that?

Mr. HUNTER. Do you think the Secretary needs some advice, a special panel that could help him to move those partitions that Lowell talked about?

Dr. PERRY. The issue—a panel or committee of this type can add limited value. What it does is illuminate the issue; it keeps that illumination on the issue and, therefore, it helps overcome the barriers to moving ahead.

We see this program as requiring some discontinuity, some change from doing business as usual, and imposing an outside committee of this sort does help provide the ongoing pressure to see that that is done. This panel has written its report. This report will be an impulse into the system, but the follow-up to the report is what is going to be critical and we see the committee, then, as being useful in providing a conscience to see that that follow-up is done.

Mr. BENNETT. We appreciate your having done that. Mr. McCurdy.

Mr. MCCURDY. Thank you, Mr. Chairman.

I want to join my colleagues in welcoming the gentlemen before us today and also to commend both Chairs of the full committee and subcommittee for holding this hearing, and primarily to the panel for your contribution.

It is an interesting debate and it is an interesting report and one that I think is timely. I look at the membership of the panel and see some individuals who have had a wide array of experience and backgrounds. I know that Admiral Burkhalter and I had a few discussions a few years ago when I was previously on the Intelligence Committee regarding the establishment of some independent research efforts to look at nonacoustic ASW, which later became known in the unclassified terms, tsunami, which is a Japanese

word for tidal wave, which although not exactly relevant, it is funny that the computer threw out a name that had some relevance to the ocean, anyway. At that time, when we started that effort, it was actually the gentleman from Arizona, Mr. Stump, who had to leave, and myself because we were jointly on this R&D Subcommittee, but also the Intelligence Committee, and you would have thought that these two landlubbers who got involved in this had just opened up the crown jewels and were exposing it to the world. We were attacked by every quarter and that many people thought that the Navy was doing perfectly well looking at these efforts on their own, that ASW was exclusively the jurisdiction of the Navy, that Congress certainly shouldn't even begin to look in that area and that we were micromanaging and prying into areas that we shouldn't be involved in.

But quite frankly, I think the Navy would be the first to admit, and they have to me and others, that because of the quality of research done in that program, the amount of investment which was nominal compared to some of the other—nominal compared to the risk involved, I guess—that there was very useful information that came out of it. They found that they could actually work with a sister agency, that it wasn't leaked everywhere around the world and that there was some valuable contributions.

So I think we have learned a lesson. Of course, we started with DARPA in trying to do our advanced technologies program and that, too, came under attack and the motivation of the Congress to even set up an independent review was minimal. I now know that the Navy has started their C-92 project and other projects to look at advanced research. Then your panel report is overlain on top of that, and that is that you still believe that there should be some independent review.

So basically my question is—and this is certainly not intended to attack your credibility, but it is one of the difficulties we have here is that even when we pull together a body of experts in industry, the Navy controls most of the funding of research in the areas; they control the information base, all the testings and soundings are controlled basically by the Navy, and they do maintain considerable control over the types of research efforts that are ongoing.

If you, as a panel of industry experts, who have some association with the Navy come forward with this recommendation, are we to read in, as diplomatic as you might be and as undiplomatic as some of us might be, that perhaps this is a greater problem than actually stated, and that are you not saying that the Navy has not cooperated enough with other agencies or they are hiding information or what kinds of things could be inferred from your concerns? Or is it just, "Well, we ought to make it a higher priority and someone else ought to kick money into the pot"?

Dr. Wood, you are never shy. You and I and others have debated a lot of issues up here and I would like for you to be candid again.

Dr. WOOD. Mr. McCurdy, first of all, for starters, there is no doubt but that the tsunami project has served the national interest very well. To the extent that the Congress brought that into existence and insisted on its continued existence, they did a job which, if it was micromanagement, the DOD needs more of it.

With respect to the other issues that you have raised, of course the Navy is the major player in the area. They will be as far as the eye can see. They dominate the funding; they dominate the data; they dominate access to platforms. All of those things are givens. Those things are not really, as a practical matter, subject to change.

It is because of those reasons that the panel—which is not, obviously, here showing either for ASW or for the Navy as an institution—but the panel so warmly commended to the Congress not only the existence, but the stable, durable funding of not alternative programs, but of supplemental programs in DARPA, in advanced technology, and in the CIA with emphasis on monitoring of advanced Soviet developments.

These two agencies have shown real promise in their efforts to the present time to serve U.S. national interests and to serve the Navy's long-term interests. They are certainly things that—two efforts that we, throughout our report, have warmly commended to the Congress, not that they have done well through the present time, but that the Congress will do well by the country if it sustains them into the foreseeable future.

Mr. McCURDY. I thank the gentleman.

Admiral.

Admiral BURKHALTER. Can I add to that, Mr. Chairman?

Mr. McCurdy, as you stated, you and I had discussions along these lines several years ago when I was still on active duty. To answer your question, I—

Mr. McCURDY. By the way, wearing two hats as Director of NSA and also as a submariner, I recognize that you speak with great experience and a wealth of information.

Admiral BURKHALTER. To answer your question, it is my own opinion that Navy and the other agencies that have been involved, the CIA and others, have developed a strong professional cooperative effort. I think that both of those agencies will tell you that they have benefited from this effort and that I think the national interest has been served in that regard.

Dr. PERRY. Mr. McCurdy, I would add one other point, if I may.

This problem, as we have said before, is an exceedingly difficult technical problem and one which requires some discontinuity from the past, some breakthrough. For that reason alone, it is appropriate to have DARPA involved in it. Regardless of how vigorous and how effective the Navy R&D program was, it is appropriate to have DARPA in because of the importance and the difficulty of the problem. Because of the possibility that there may developments made in the Soviet Union ahead of us in this field, it is appropriate to have the CIA involved.

So we do not need to posit an uncooperative or an unvigorous Navy to argue that we ought to have DARPA and the CIA involved in the program.

Mr. BENNETT. Mrs. Byron.

Mrs. BYRON. Thank you, Mr. Chairman.

Let me follow along on reading your summary and apologize for getting here late, but as we all are talking about, day-in and day-out, the limited dollars and our limited resources and where we are going to go with putting our priorities in order, your suggestion in

ASW that we need to start over—there are three key areas of question, in my estimation, in ASW, and that is should we go for speed, for noise abatement or depth?

When we are looking at the dollar issue, in what area should we put the main thrust? I see I am getting a great deal of a negative, and obviously you would like to answer that one first, so Dr. Rosenbaum, you——

Dr. ROSENBAUM. Thank you. If we were addressing just submarine technology questions about speed, depth or quietness would be very relevant? However, we are trying to address ASW here, in addition to submarine technology.

Mrs. BYRON. I prefaced it with ASW.

Dr. ROSENBAUM. I know.

ASW does not necessarily mean the use of a U.S. submarine as the ASW platform. It means the use of all the assets the United States can bring to bear to defeat the enemy submarine. That means sensors and other kinds of platforms which——

Mrs. BYRON. Is that not——

Dr. ROSENBAUM. May have nothing to do with speed, depth——

Mrs. BYRON. Is noise abatement to sensors?

Dr. ROSENBAUM. I got the impression that you were equating ASW to U.S. submarines. That is an identification which might not exist as strongly as it has in the past especially in face of the future threat.

The point of what we have tried to suggest here is that defending against an enemy submarine may have also little to do—it may have a lot to do, but it may have little to do with our own submarine force. That is, the forces that we bring to bear to defend against the submarine might not even include our own submarines.

Dr. WOOD. As an extreme but by no means absurd example, Soviet submarines, which is what we are concerned with in antisubmarine warfare, might be located by assets in orbit and fired upon by missiles which are based on the Continental United States.

Mrs. BYRON. I was getting ready to ask, are we looking at a potential SDI in the sea?

Dr. WOOD. More of a conventional defense initiative in the sea. We are keenly interested in maintain the sealines of communication between the Continental United States and our allies.

That threat is probably—the threat to those sealines is probably not of a nuclear nature; it is posed by the hundreds of Soviet attack submarines. ASW is primarily concerned with localizing those submarines and prosecuting attacks against them.

The preferred platforms for localizing them or for attacking them, or both, may be U.S. submarines, but it may not be. In particular, as I said, their localization may be done by very distant means. Attack on them may be conducted with means which are also very distant.

Mrs. BYRON. Which goes back to my basic question, with the limited number of dollars, how do we stretch them?

Dr. SMITH. Could I respond to your statement regarding SDI, Congressman Byron?

Mrs. BYRON. Yes. I thought that a waterlogged SDI might get a reaction.

Dr. WOOD. But not from me.

Dr. SMITH. I would like to make it very clear that this panel is in no way recommending an SDIO. We are not calling for a special initiative, a new office, et cetera. ASW is indeed the responsibility of the Navy, and in response to Mr. McCurdy's points, the Navy has been improving its ability to work with the other agencies that Dr. Perry has mentioned.

It would be premature in the extreme, I would think, to set up an SDIO for ASW.

There is no need for an SDI in this area. There is need for recognition on the part of this committee, on the part of the full committee, on the part of Mr. Cheney and on the part of the Navy of the critical importance that this country has to place on anti-submarine warfare for the reasons that Dr. Perry presented, I think very clearly, at the beginning of the testimony.

Dr. WOOD. To underscore Dr. Smith's latter points, this is not a small-scale issue in any sense. To duplicate the SOSUS system, which has been the mainstay of U.S. passive acoustic ASW capabilities in the last three decades, to duplicate that system in current dollars would require between $50 and $75 billion.

The operation of that system over the decades it has been in existence has cost in present dollars at least that much money. So the scale of the new ASW capabilities that we are talking about is by no stretch of the imagination less than $100 billion. It might easily be twice that.

Mrs. BYRON. Thank you, Mr. Chairman.

Mr. BENNETT. Mr. Hopkins.

Mr. HOPKINS. No question, Mr. Chairman. Thank you.

Mr. BENNETT. Mrs. Schroeder.

Mrs. SCHROEDER. No questions, Mr. Chairman.

Mr. BENNETT. That was a bombshell of a final note that you just added that dollar figure to, but it does put it in perspective without having such a finite figure suggested. It would not have been a complete hearing and I am glad you did point it out.

It is not only a very difficult research matter, it is also a very difficult administration matter, to fit it into the way in which the military operates. It is also a very difficult financial matter, but it can't be swept aside. It is important unless the whole war would be over in a very brief period of time, as used to be the concept to people. It is no longer the concept of most people.

If it goes any length of time at all, the sealanes do have to remain open and there is no way in which we would expect to see success on our side without having them open.

You have certainly earned the gratitude of your country in making the study you have made and I appreciate it very, very much. We will take it up with the other members of the establishment, the Navy and others, to see what we can do to put it on the front burner.

Mr. Hunter has a question he would like to ask, an additional question.

Mr. HUNTER. Just one question. Realizing that we are talking about ASW and not submarines, there is a relationship between our force and approximately 100 boats and the Soviets. It is about three times that much, and the fact that we have been able to live

with the numerical inferiority because of the qualitative delta that has now shrunk.

Does anybody have any comments about our proposed production rate? For example, when we get into the 21s, we are going to be building two a year at some point and maybe three a year. The Soviets have roughly twice the production rate on attack boats.

Has it come time for us to reevaluate in light of the shrinking qualitative difference the three-to-one numerical disadvantage that we live under with the Soviets? So we are talking about production at that point.

Dr. PERRY. That is a good question. The panel did not look into that, and as a panel, would not have any informed views on it. Maybe individuals on the panel would like to express an opinion on that.

Mr. HUNTER. Should we look into that?

Dr. WOOD. The points you made with respect to quantitative versus qualitative superiority are certainly correct. There is no doubt that the Soviets, while producing noisier boats, have also been producing them in much greater quantity.

The key issue that must be examined and decided upon by the Congress with respect to ASW is the not anti-surface warfare or anything else, but anti-submarine warfare is the partitioning of the resource—the basic partitioning of the resources, the macromanagement and the determination of whether or not, for instance, the SSN-21s or their follow-on platforms or any adjuncts or whatever, what is the best way that, in a world of finite resources, the U.S. is going to prosecute the ASW mission?

How are we not going to put more subs at sea on our part, necessarily? How are we going to make sure that all of the Soviet subs which are put to sea are negated with respect to blockage of the sealines of communications?

The ASW task is not necessarily connected with submarines, U.S. submarines, in the long haul. The Congress needs to get the best technical, the best management, the best financial inputs it can and make the determination over the next decade, maybe two decades, with respect to what the best U.S. capability to negate the Soviet submarine capability can be and how it is to be gained.

It is not necessarily by building a lot of submarines.

Mr. HUNTER. So the production is a piece of the issue.

Dr. WOOD. It is very likely to be a substantial piece of the issue, but it may not be the dominant feature of the solution that we are calling for in our report and here today.

Admiral BURKHALTER. Mr. Hunter, could I answer one specific part of your question regarding the Soviet improved technology?

Mr. HUNTER. Sure.

Admiral BURKHALTER. I don't know if it has been discussed in the panel earlier, Mr. Chairman, and I apologize for coming in late, but I would like to comment on what the Navy has done and has briefed us and other things that we have observed in the past year and putting a much more formal structure into their own R&D program, and establishing a separate office over in the Naval Sea Systems Command now that addresses long-term R&D technologies, the dedication of first one and then, I believe, a follow-on SSN for at-sea R&D experiments and development work.

I think that in the long run, also working with DARPA in their own programs, that this will help the U.S. to continue with the technological advantages they have had in the past. I think that is a very positive thing that we have observed as a panel during the time that we have been meeting, this evolution of the R&D programs in the Navy that we have seen.

Mr. HUNTER. Thank you, Mr. Chairman.

Mr. BENNETT. The Congress is grateful and the country is grateful for the good service you have had and we deeply appreciate what you have done.

The next meeting of the Seapower Subcommittee will be on April 5. The next meeting of the Research and Development Committee will be tomorrow morning at 10:00.

The meeting is adjourned.

Dr. PERRY. Thank you, Mr. Chairman.

[Whereupon, at 11:45 a.m., the subcommittees were adjourned, to reconvene subject to the call of the Chair.]

# THE STRATEGIC DEFENSE INITIATIVE PROGRAM

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Wednesday, March 22, 1989.*

The subcommittee met, pursuant to notice, at 1:35 p.m. in room 2212, Rayburn House Office Building, Hon. Charles E. Bennett presiding.

## STATEMENT OF HON. CHARLES E. BENNETT, A REPRESENTATIVE FROM FLORIDA

Mr. BENNETT. The subcommittee will please come to order.

This afternoon, the Research and Development Subcommittee will meet in open session to receive additional testimony on the Strategic Defense Initiative Program.

Last Tuesday, March 14, the subcommittee heard testimony from the new Director of SDIO, General Monahan. That testimony was primarily based on the Reagan $5.6 billion SDI budget. We are still waiting to hear the results of Bush's re-evaluation of the defense budget.

The subcommittee has invited two individuals to testify to give us some additional diversity of opinion over the administration's program. Dr. Sidney Drell is Professor and Deputy Director, Stanford Linear Accelerator Center, Stanford University, and Co-Director, Stanford Center for International Security and Arms Control.

Dr. Angelo Codevilla is a Senior Research Fellow at Stanford University's Hoover Institute and has served as a Senior Staff Fellow of the Senate Select Committee on Intelligence and Staff Assistant to Senator Malcolm Wallop.

I have asked our witnesses to provide a brief statement and then we will open the session to questions from the subcommittee.

In this, I am speaking for the actual Chairman, Mr. Dellums, of this committee. He asked me to fill in until he could join us. At this time I would like to submit for the record Mr. Dellums' prepared statement and an article published by *Christian Science Monitor* that was co-written by Mr. Ridge and me concerning SDI.

PREPARED STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

The subcommittee will please come to order.

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Before we begin, I would like to recognize Bill Dickinson, the ranking Republican on the subcommittee, for such time as he may consume.

[A newspaper article written by Messrs. Bennett and Ridge, follows:]

THE CHRISTIAN SCIENCE MONITOR
Monday, March 20, 1989

# A Star Wars Proposal

## By Charles E. Bennett and Tom Ridge

'We need compromise; we've had dissension," President Bush said in his inaugural speech. Just so. It's time to resolve one of the most divisive defense issues, the Strategic Defense Initiative (SDI).

Sold to the American people as a way to make nuclear weapons "obsolete," the program was still portrayed by President Reagan last year as "a defensive weapon that would make it virtually impossible for nuclear missiles to get through."

As former Sen. John Tower acknowledged, that vision is "unrealistic." Frankly there has been a lot of dreaming that achieved a degree of acceptance because it was done in high places by people who know something about defense. It's left us with a serious defense problem.

The budget now before Congress is still guided by the dream of moving SDI off the drawing boards and into production. The budget asks for $6 billion for SDI—an increase of $2 billion over last year. It also requests $262 million for the full-scale development of "Phase I of the Strategic Defense System." This amount would grow to $427 million next year. Budget projections show the total cost of deploying a Star Wars system skyrocketing in the 1990s to tens of billion of dollars per year.

**There is growing consensus that neither our technology nor our finances can support deployment of SDI.**

There is growing consensus that neither our technology nor our finances can support deployment of SDI. The question for President Bush and the Congress is: How do we resolve this issue which has generated such ardent emotions?

For three years we have authored the amendments that have set the funding level for SDI in the House. This year we offer a compromise: The Administration agrees to trim the SDI research budget to $3 billion a year. In turn, the Congress agrees to provide program stability by authorizing funds for two years.

SDI supporters might scream this is capitulation, not compromise. They know, however, that in this era of declining defense budgets, grandiose plans for annual increases of 50 percent are unreal. Their fallback position currently circulating is to go for increases of 10-15 percent per year and try to get a commitment to build a partial, ground-based system, much like the Safeguard system proposed in the early 1970s.

But support for this plan is weak. Even annual increases of 10 percent jump the SDI budget to $5 billion in two years and $6 billion in four years. This is too much for our now limited defense budgets and too little for the kinds of weapons systems envisioned in the near future. Of course, even this partial system would mean breaking out of the 1972 Anti-Ballistic Missile Treaty and would start a new arms race with the Soviet Union.

SDI opponents might say that $3 billion a year is too much for SDI. Last year, 120 members of the House voted to cut the budget to $1.5 billion. This amendment was offered by Rep. Ron Dellums, now chairman of the Armed Services subcommittee overseeing the SDI program. $3 billion may be more than is needed, but we would compromise in order to put this contentious debate behind us.

A consensus exists for a sustainable, robust research program. Last year, 25 members of a special House task force on SDI—both supporters and critics—agreed that research should continue, but not at the expense of other military programs and not in violation of the ABM Treaty. Scientists within and outside the SDI program testified that $2 billion to $3 billion per year is adequate to do research into the advanced technologies that might someday make the weapons feasible. As the defense industry paper Defense News editorialized last month, "Stable funding of $3 billion a year is sufficient for this experimental research program."

The Administration and Congress may be closer on this issue than some believe. National security adviser Brent Scowcroft talked candidly to the task force last April. "I don't like the first phase [of deployment]," he said, "because it changes the whole notion of what the program was intended to find out." He felt that mobile missiles and arms control were better ways of dealing with any ICBM vulnerability than deploying Phase I. While proponents are now trying to sell SDI on the grounds that it would complicate Soviet attack plans and thus enhance deterrence, Scowcroft said that Phase I "would enhance deterrence only in the sense that it would force a very heavy attack" by the Soviets. He explained, "I think there is a real problem with enhancing deterrence at the cost of increasing crisis instability or at least arms race instability." Scowcroft told the task force that adhering to the traditional interpretation of the ABM Treaty for 10 years "would not hamper very seriously what we need to do" in basic research.

With the White House and the Congress in agreement, SDI research would provide strong bargaining leverage in negotiations with the USSR to reduce our nuclear arsenals and improve strategic stability. And the Administration would still have a robust research program with a substantial budget. Further development or deployment of an SDI system would remain an option when—or if—the technologies matured.

Arguments about SDI have consumed too much time. They have obscured the real challenges the US confronts, including the need to improve conventional forces to deter the most likely kinds of war. A huge budget for SDI is simply not sustainable when the country confronts severe crises in trade, banking, nuclear arms and conventional forces.

It's time to talk sense about strategic defense.

■ *Charles E. Bennett (D) of Florida and Tom Ridge (R) of Pennsylvania are members of the US House of Representatives.*

Mr. BENNETT. Before we begin, I would like to recognize Mr. Kyl, if he has any remarks he would like to make.

Mr. KYL. Thank you, Mr. Chairman. Perhaps I could read into the record the remarks that Mr. Dickinson had prepared.

Mr. BENNETT. Good.

Mr. KYL. I hope and expect that he will be here.

Mr. BENNETT. Here he is.

Mr. KYL. As a matter of fact, here's Bill.

[Laughter.]

Mr. KYL. I was about to read your statement into the record.

**STATEMENT OF HON. WILLIAM L. DICKINSON, A REPRESENTATIVE FROM ALABAMA, RANKING MINORITY MEMBER, RESEARCH AND DEVELOPMENT SUBCOMMITTEE**

Mr. DICKINSON. Thank you, Mr. Chairman. Thank you, Mr. Drell, and Dr. Codevilla, for your appearance here. We spend a lot of time debating SDI and it has always been helpful to hear divergent opinions from outside the administration, because only in that way can we really get an objective and well-rounded view.

If you followed the congressional debate on SDI during the past several years, you would find that a lot of attention has been paid to the minor issues involving particular programs, funding levels, and so forth.

Other than the badly mishandled ABM Treaty interpretation issue, Congress has not spent a great deal of time looking at the broad requirements for, or implications of, proceeding with strategic defenses.

Until the Bush administration makes a sustained and compelling case for proceeding with development of SDI which by definition, means re-negotiating or abrogating the ABM Treaty, it will become increasingly difficult for Congress to appropriate $4 billion a year for the program, regardless of its importance.

Thus, I am glad we have asked our two witnesses to appear today. Rather than asking engineers, program managers, or administration witnesses without guidance to comment on some of the major issues relevant to the strategic defense, it is useful to have outside experts with the proper background and experience to do so.

I want to commend the Chairman for calling this hearing and look forward to your testimony.

Mr. DICKINSON. I might say parenthetically that one of the staffers, Mr. Andy Ellis, who normally would be sitting in for us on this side, was otherwise indisposed with his wife delivering him a son or a daughter today.

Mr. BENNETT. How wonderful. That is great.

Mr. DICKINSON. If it has not already happened, it is in the process right now. So that accounts for his absence. Thank you for your presence here today. Thank you, Mr. Chairman.

Mr. BENNETT. Dr. Drell, would you then begin your statement?

**STATEMENT OF DR. SIDNEY D. DRELL, DEPUTY DIRECTOR, STANFORD LINEAR ACCELERATOR CENTER, STANFORD UNIVERSITY AND CO-DIRECTOR STANFORD CENTER FOR INTERNATIONAL SECURITY, AND ARMS CONTROL.**

Dr. DRELL. Fine. Thank you, Mr. Chairman, for this opportunity to testify today.

I speak only of my own views drawn from my experience in this field for many years, as detailed in the CV added to the written testimony I have submitted for the record.

My recommendations for a constructive strategy for the near term R&D program in strategic defense are guided by the following three judgments:

One, R&D should be emphasized rather than early deployment. At this time there is no nationwide ABM system concept whose technology is sufficiently far advanced to be worthy of deployment.

Extensive investments in engineering development, demonstration, validation and preparation for deployment are at this stage wasteful of resources because of the immaturity of both defensive technologies and systems.

Two, a technical and military case for limited deployments to defend the National Command Authority, the retaliatory forces, or the whole Nation against a small or accidental launch has not been made yet either.

But a functional prototype system of ground-based interceptors, radars, and communications for a terminal nuclear-armed defense that is consistent with the ABM Treaty would be valuable in providing a technology hedge against future threats and a test bed for developing and evaluating penetration aids.

Third, I believe it is important to maintain the ABM Treaty as its meaning has been traditionally understood. It provides a basis on which to negotiate a more stable strategic balance at a lower level of offensive forces, while at the same time pursuing an active program in technology for strategic defense and keeping important restraints on Soviet activities and their strategic defense program.

The treaty's restraints on the testing of systems components are the key to its effectiveness in preventing preparations for rapid deployment of a militarily effective defense system following breakout.

Consistent with these judgments, I assign top priority to two programs in strategic defense: development and engineering of a treaty-consistent functional prototype system for a terminal nuclear-armed defense at the Kwajalein test range and expanded R&D on sensors for mid-course discrimination. An annual budget of $3 billion can support the tasks within the various program elements that are described, together with their rough costs, in the paper I have submitted.

Since the strategy of the research program must be designed to find out how far we can go toward solving the many problems of strategic defense, and whether or not the answers can be put together in a sensible system that accomplishes military objectives and political support, this program should not be burdened as SDI has been in the past by a political requirement to proceed by the shortest possible route to deploy something.

Hence, the program strategy should be organized around the five technical areas which constitute the major unanswered questions.

The first of these is what I will call warning, surveillance and tracking. The major space-based assets for surveillance and tracking of SDI are the boost-phase surveillance and tracking satellite, the BSTS, and the space surveillance and tracking satellite, or the SSTS.

The requirements for and the design of these satellites have been heavily driven and frequently changed by rudimentary and changing concepts of particular overall strategic defenses of which they might be parts. This was most poignantly demonstrated by the recent reduction of planned SSTS capabilities in order to cut the phase one strategic defense system costs by a factor of two.

Since it remains premature in my judgment to discuss actual deployment of a major strategic defense system, we should not constrain development of these technologies by putting our investment into the engineering of large demonstration and validation projects, the DEM/VAL projects.

Technology development, integration and testing to answer questions of cost, weight, and required reliability should be the focus of the R&D program.

As to mid-course discrimination, the ability to discriminate warheads from decoys in midcourse above the atmosphere is very important for a strategic defense which could launch multiple attacks during the long, mid-course phase which is most of the time spent during the traversal of warheads in a ballistic missile system.

The major problem standing in the way of effective mid-course attacks is decoy discrimination, a problem that has remained largely intractable for the last 30 years. The program strategy of the SDI so far has not recognized the significance of discrimination explicitly in setting project funding priorities.

In the technical area of the kinetic energy weapons, kinetic kill vehicles, space-based interceptors have received significant emphasis in recent program strategies of the Strategic Defense Initiative because they are perceived to represent the only near term means of attacking ICBMs in boost phase.

Impressive advances in the design of these interceptors have occurred and the results of this work may have useful applications more broadly.

However, in consonance with my view that near term deployments are not feasible, elaborate demonstration and validation projects for these space-based interceptors are counterproductive.

Continued R&D in this area is more appropriate, more valuable and less expensive, I might add.

On the issue of nuclear-armed interceptors, and our present insistence that a strategic defense be non-nuclear, we should keep in mind that nobody's concept of SDI will eliminate nuclear weapons.

In fact, a totally non-nuclear strategic defense may collapse against an offense employing salvage fusing or nuclear precursors.

This issue becomes particularly acute in the discussion of ground based terminal interceptors which have precious few seconds and limited space to make their intercept.

I disagree strongly with the downgrading of this technology in the current SDI program relative to the strong emphasis being put

on the much more difficult technology of kinetic energy weapons that must make a direct impact to destroy their targets.

As to directed energy weapons, no part of the SDI has received as much publicity or engendered so many misunderstandings as directed energy weapons. In recent years a number of technical studies have demonstrated how far directed energy weapons are from achieving practical military value.

Nevertheless, it remains true that some classes of directed energy weapons show real promise of utility in a range of military missions. The current program, however, is simply trying to do too many things so that directed energy weapons remain unlikely for purely programmatic reasons to make any real contributions to military systems.

As to funding priorities, on page 7 of my prepared statement, I show what I would consider a typical budget, and I divide the funding up among the categories of surveillance, acquisition, tracking and kill assessment; directed energy weapons; kinetic energy weapons; systems analysis and battle management; survivability, lethality and key technologies; and the Department of Energy. That is the way the budget is presented. The first five categories are DOD, the sixth one is the Department of Energy.

This gives an idea of how I would cut down to a $3 billion budget which I believe is fully adequate to support the research tasks.

Top priorities, again to repeat, should be given to two programs: development and engineering of a functional prototype terminal nuclear intercept system in consonance with the ABM Treaty at the Kwajalein test range and expanded R&D on mid-course discrimination.

The first of these, the functional prototype, is a hedge against technological breakthroughs, against future threats, and serves importantly as a test bed for developing and evaluating penetration aids that we may need for our offensive forces.

The second one, the mid-course discrimination R&D, is necessary because it is crucial and we do not know how to do it at this time.

I would assign second priority to broad R&D on other sensor systems and third priority to development of directed energy weapons with significant promise, including the nuclear-weapon driven ones.

The SATKA, the surveillance category, is at nearly $1.1 billion in the fiscal year 1989 budget, this year's budget. This budget category includes several hundred million dollars worth of investment in demonstration and validation exercises for boost, mid-course and terminal systems.

Although some of the development that supports these exercises is certainly worthwhile, and we can go into it in the discussion, their overall objectives are premature. I would take out the $200 million from that category, highlighting in what remains vigorous discrimination research, R&D in relevant sensor technologies conducted in synergy with similar work supporting national intelligence assets for early warning and space surveillance for intelligence.

Mid-course discrimination research deserves a special comment, because under the SDI it has been hampered by two factors—too much support for neutral particle beam development and more importantly, the pressure to move to a Phase I SDS or strategic de-

fense system, which forced an optimism about the capabilities of infrared and optical passive discrimination measures.

Early on in the course of SDI, the consensus of long-time workers in ballistic missile defense was that passive measures—the optical and the infrared heat-seeking—would not suffice.

Considerable work has since gone into developing and testing sensors, particularly infrared ones, against known test vehicles and some public pronouncements have suggested that the prospects for success were surprisingly optimistic.

Yet, I know of no DOD review body whose opinion about the long-term prospects of passive sensors has agreed with this optimism.

In addition, nuclear precursor countermeasures could be effective against passive systems that might work otherwise in addition to problems created by decoys.

Similarly, extensive debates in the literature about the precise difficulties involved in giving decoys the same thermal and dynamic properties as RVs have largely missed the key point about offensive countermeasures.

An offense, responding to such discrimination efforts, would not attempt to make decoys look like warheads, that is simulation, nor the converse, anti-simulation, trying to make warheads look like decoys.

It would be most likely to devote its efforts to making every one of the hundreds of thousands of objects in space look distinctly different from all the others. It would be a matter of confusion.

In such a threat environment, the precise signatures observed in Soviet RV tests would have little meaning, as would techniques based on comparisons normalized to such signatures.

As to directed energy weapons, changing fashions have taken a considerable toll in the progress toward attainment of an actual military capability using directed energy weapons. Chemical lasers, the most intensely funded and promoted before SDI, first fell in importance, and now have recovered to assume a prospective role in the Phase II architecture. Recent SDIO funding actions suggest that free electron lasers, too, have lost their pre-eminent place at the top of the priority scale and might be decelerated as rapidly as they were accelerated.

The susceptibility to direct attack of space-based chemical lasers in low orbits looks just as lethal now as it did when they were first de-emphasized in the early years of SDI. The possibility of developing very high brightness chemical lasers, allowing them to be put out of easy reach of direct-ascent interceptors, seems remote, given the last decade's history of development difficulties. Chemical lasers in space should be eliminated from consideration as weapons for ABM systems.

Work on neutral particle beams should be reduced to a small program of accelerator R&D. It can be done on ground. Both survivability and system size and complexity issues have plagued proposed neutral particle beam discriminator schemes and have not received adequate answers.

Currently there is a large program to develop a multi-megawatt free electron laser at White Sands. This project, should proceed at a physics and technology-limited pace, or until experimental evi-

dence demonstrates either that the laser will not produce requisite beam and power characteristics or that the beam will not propagate through the atmosphere.

As to kinetic energy weapons, first priority in this category should go to the development of the terminal nuclear interceptor to form the basis of the functional prototype system, the ground-based terminal nuclear interceptor.

The existing HEDI, high-endo defense intercept project, with some modifications, can serve this purpose.

Second priority should then go to development of a longer-range ground-based exo-atmospheric interceptor, currently the ERIS, extended range intercept system program.

Finally, the space-based interceptor program should be reduced to technology development for small, smart interceptors to see just how small and how smart they can be made. We do not know. Some SDIO projects are currently working in this direction, but the large development program aimed to support an early Phase I deployment is counterproductive.

Let me just wind up the other comments in my written testimony by saying a high quality and balanced research and technology program in strategic defense that is consistent with the ABM Treaty is in the security interests of the United States. It is my technical judgment that compliance with the treaty will pose no harmful technological burden on a properly structured U.S. program for the coming decade.

A program on strategic defense will be more likely to achieve its goals of determining what advance technologies look promising and what systems concepts look practical if its research priorities do not put premature emphasis on large scale technology demonstrations in space. $3 billion a year is fully adequate to support the program with the research strategy and funding programs that I have outlined.

Thank you, Mr. Chairman.

PREPARED STATEMENT OF DR. SIDNEY D. DRELL

# TESTIMONY ON THE STRATEGIC DEFENSE INITIATIVE

before

THE SUBCOMMITTEE ON R&D

of

THE HOUSE ARMED SERVICES COMMITTEE

March 21, 1989

by

**Sidney D. Drell**

Thank you for this opportunity to testify on the Strategic Defense Initiative. My statement to the Subcommittee represents my own personal views and not those of any organization. These views draw on my experience in this field and as an adviser to agencies of the U.S. government on technical issues of national security dating back to 1960.

Today I will outline what I consider a constructive strategy for the near term R&D program in strategic defense. My recommendations are guided by the following three judgments:*

1. R&D should be emphasized rather than early deployment. At this time there is no nationwide ABM system concept whose technology is sufficiently far advanced to be worthy of deployment. Extensive investments in engineering development, demonstration, validation, and preparation for deployment are, at this stage, wasteful of resources because of the immaturity of both defensive technologies and systems.

2. A technical and military case for limited deployments to defend the National Command Authority (NCA), the retaliatory forces, or the whole nation against small or accidental launches has also not been made. A functional prototype system of ground-based interceptors, radars, and communications for a terminal nuclear-armed defense that is consistent with the ABM Treaty

* The basic assumptions and recommendations in my testimony are consistent with those in the report of a workshop on this subject issued in 1985 by the Stanford University Center for International Security and Arms Control with the title "Strategic Missile Defense: Necessities, Prospects, and Dangers in the Near Term" (Sidney D. Drell and Thomas H. Johnson, co-chairmen).

would be valuable in providing a technology hedge against future threats and a test bed for developing and evaluating penetration aids.

3. It is important to maintain the ABM Treaty as its meaning has been traditionally understood. It provides a basis on which to negotiate a more stable strategic balance at a lower level of offensive forces while at the same time pursuing an active program in technology for strategic defense. The Treaty's restraints on the testing of system components are the key to its effectiveness in preventing preparations for rapid deployment of a militarily effective defensive system following breakout.

Consistent with these judgments, I assign top priority to two programs in strategic defense: development and engineering of a Treaty-consistent functional prototype system for a terminal nuclear-armed defense at the Kwajalein test range and expanded R&D on sensors for mid-course discrimination. An annual budget of $3 billion can support the tasks within the various program elements that are described, together with their rough costs, in the following sections.

## RESEARCH PROGRAM STRATEGY

A responsible R&D program in strategic defense must actually be designed along the lines of its stated intent, to find out how far we can go toward solving the many problems of strategic defense, and whether or not the answers can be put together in sensible systems that accomplish military objectives and support political goals. It should not be burdened, as SDI has in the past, by a political requirement to proceed by the shortest possible route to deploy something. Hence the research program strategy should be organized around the following five technical areas which constitute the major unanswered questions.

**1. Warning, Surveillance and Tracking.** The major space-based assets for surveillance and tracking in SDI are the Boost phase Surveillance and Tracking Satellite (BSTS) and the Space Surveillance and Tracking Satellite (SSTS). The requirements for and design of these satellites have been heavily driven by rudimentary concepts of particular overall strategic defenses of which they might be parts. This was demonstrated pointedly by the recent reduction of planned SSTS capabilities in order to lower the cost of the Phase One Strategic Defense System (SDS) architecture. The general capabilities of BSTS have been fixed (and changed) by

the requirements of particular weapons systems it was conceived as supporting in the mission of boost-phase kills of ICBMs. The precision, size and number of such satellites could vary greatly with the conceived capabilities of the missiles or directed energy weapons for which BSTS would provide key interactive data. And a strategic defense system that did not require boost-phase kill would pose very different requirements on such sensor systems. Similarly, the requirements for SSTS could change drastically between architectures that emphasized large numbers of satellites, low fields of view, and birth-to-death tracking, as opposed to those that emphasized few satellites, wide fields of view, and rapid hand-off after acquisition.

Since it remains premature to discuss actual deployment of a major strategic defense system, it is unnecessary to constrain development of these technologies by putting one's investment into the engineering of large demonstration and validation (DEM/VAL) projects. In fact, the technologies for performing these missions are in a period of extremely rapid advance. Solid state research is producing better sensors for a variety of wavelengths; microelectronics is producing more efficient and more reliable charge-coupled devices and efficient special-purpose computers for large-array integration; and new optical techniques (and supporting computations) suggest the possibility of very large fields of view. The critical questions for these technologies concern the actual extent of capabilities we can achieve as functions of cost, weight and required reliability. Technology development, integration and testing to answer these questions should be the focus of the R&D program.

**2. Mid-course Discrimination** The ability to discriminate RVs from decoys in midcourse is very important for strategic defense. Without a mid-course component, a multilayer strategic defense that employes only boost-phase and terminal components is unlikely to achieve high effectiveness against a large threat. In contrast to the boost-phase component of the defense which faces severe and unsolved technical requirements of operating in a highly automated manner with very short warning and engagement times, a defense can launch multiple attacks during the long midcourse phase.

The major problem standing in the way of effective midcourse attacks is decoy discrimination, a problem that has remained largely intractable for the last thirty years. The program strategy of the SDIO thus far has not recognized the

significance of discrimination explicitly in the setting of project funding priorities. A better program strategy would attack discrimination as broadly and imaginatively as possible.

**3. Kinetic Energy Weapons.** Kinetic energy weapon development has proceeded under SDIO in four general categories: small interceptors designed to be space-based, and to attack missiles in both boost and mid-course phases; ground-based exoatmospheric interceptors, moderate acceleration rockets designed to attack in the mid-course and the very early stages of re-entry; ground-based endoatmospheric interceptors, high acceleration rockets designed to attack within the atmosphere, after drag has removed most of the decoys from the threat cloud; and hypervelocity concepts, such as electromagnetic launchers.

Space-based interceptors have received significant emphasis in recent SDIO program strategies because they are perceived to represent the only near-term means of attacking ICBMs in boost phase. Impressive advances in the design of these interceptors have occurred, and the results of this work may have useful application elsewhere in defense programs. However, in consonance with the view that near-term deployments are not feasible, elaborate demonstration and validation projects for these space-based interceptors are counter-productive; continued R&D in this area is more appropriate.

In general, exoatmospheric interceptor research supports a range of possible midcourse intercept possibilities, depending on the particular characteristics of a workable decoy discrimination technique, assuming one is developed. These interceptor development programs, both space-based and ground-based, should be designed in the light of that general objective. Endoatmospheric interceptors are discussed in the following subsection; hypervelocity interceptors have not demonstrated sufficient promise to justify their being a major consideration in program strategy.

**4. Nuclear Interceptors.**

If strategic defense against ICBMs and SLBMs were indeed capable of making nuclear weapons totally obsolete, one might argue that the strategic defense itself should also abjure nuclear weapons, thereby eliminating them entirely. But, even if the SDI were one hundred percent successful in its goal of protecting against ICBMs

and even if it were somehow extended to deal with SLBMs as well, that would still leave thousands of nuclear weapons deliverable by cruise missiles, aircraft, short-range missiles, and cannon. In short, nobody's concept of the SDI will eliminate nuclear weapons. In fact, a totally non-nuclear strategic defense may collapse against an offense employing nuclear precursors.

This issue becomes particularly acute in the discussion of terminal interceptors. Achievement of zero-miss distances at high reliability, using homing missiles with velocities above 5 km/sec in the atmosphere, is a terribly difficult task. To expect those same interceptors to deal with responsive threats, particularly maneuvering RVs, in unrealistic. Putting small nuclear weapons in the interceptors permits a system design based on miss distances that are in a practically realizable realm. Thus, the program strategy must encompass research and analysis that includes the possibility of nuclear interceptors. I disagree with the downgrading of this technology in the current SDI program relative to the strong emphasis being put on the much more difficult technology of kinetic energy weapons that must make a direct impact to destroy their targets.

**5. Directed Energy Weapons.** No part of the SDI has received as much publicity, or engendered so many misunderstandings, as directed energy weapons. In recent years a number of technical studies* have demonstrated how far directed energy weapons are from achieving practical military value.

Nevertheless, it remains true that some classes of directed energy weapons show real promise of utility in a range of military missions. What must be done is to relieve the dominance of fashion and political patronage from the design of directed energy R&D, and to set priorities rationally within a moderate overall budget. Historically, that total has been roughly 20-25% of the total of strategic defense R&D, which seems reasonable. The priorities should be set to support through the development cycle one or two candidates that continue to show promise. At the same time, a strong technology base must be maintained, particularly in optics and control techniques. The current program is simply trying to do too many things. so that directed energy weapons remain unlikely for purely programmatic reasons

* See in particular the 1987 Report by the Study Group of the American Physical Society on "The Science and Technology of Directed Energy Weapons".

to make any real contribution to military systems.

In addition to these five technical areas, I emphasize the importance of creating two effective advisory bodies as part of the research program strategy. Their primary role is to ensure that the U.S. effort in strategic defense, which currently is the country's largest technical R&D program, will remain responsive to national objectives and be of the highest technical quality.

The first advisory body is a technically strong and independent "Red Team," with a close connection with the intelligence agencies. The function of this team is to challenge the ability of proposed defensive technologies and architectures to remain effective in the face of responsive offensive countermeasures, consistent with the two Nitze criteria of survivability and cost-effectiveness at the margin. It is essential that in the future "Red Team" activities receive serious funding support and that, in contrast to current procedures of the SDI program, it reports to a senior level in the Pentagon outside the Strategic Defense Initiative program office. Future Red Team work should include significant participation by companies actually involved in hardware R&D and testing, and should be continuous operations, rather than sporadic "exercises." All program plans and experimental proposals should be reviewed by the Red Team and recycled several times with the system designers before being actually proposed and funded. The Red Team should work closely with the strategic offense R&D projects developing penetration aids, including decoy techniques.

The second critical advisory body is a senior-level, independent panel composed of individuals with diverse experience and expertise whose task is to advise the government at a very high level (for instance, the National Security Council) on the architecture of our strategic forces. The panel should maintain knowledge of the technical and programmatic status of work on strategic systems that is sufficiently detailed for it to advise the government on the setting of priorities. The panel should also conduct periodic reviews to insure that the work remains in close harmony with U.S. overall strategic goals and policies, both military and arms control.

## FUNDING PRIORITIES

I now turn to the funding priorities for a sample R&D program in strategic defense whose priority research goals are consistent with the technical judgments and the research strategy described above. An annual budget of approximately $3 billion is fully adequate to support these tasks.

The major change from FY89 with its total annual cost of close to $4 billion is the elimination of wasteful demonstration/validation projects and preparations for Phase I SDS. Table I for FY90 presents a representative balance of funds among the different program elements, subject to overall priorities that are discussed below. The budget comprises five major categories of R&D: Surveillance, Acquisition, Tracking and Kill Assessment (SATKA); Directed Energy Weapons (DEW); Kinetic Energy Weapons (KEW); Systems Analysis and Battle Management (SA/BM); and Survivability, Lethality and Key Technology (SLKT). An additional major component is work performed by the Department of Energy (DOE), principally on nuclear-weapon-driven directed energy weapons R&D. Finally, additional small amounts are included for headquarters management and construction.

**TABLE I**

| | PROPOSED FY90 | FY89 (for comparison) |
|---|---|---|
| SATKA | $900M | $1093M |
| DEW | 650M | 819M |
| KEW | 700M | 773M |
| SA/BM | 250M | 486M |
| SLKT | 250M | 406M |
| DOE | 250M | 336M |
| **TOTAL** | $3000M | $3913M |

Two programs should be given top priority: development and engineering of a functional prototype terminal nuclear interceptor system at the Kwajalein test range and expanded R&D on mid-course discrimination. Second priority is assigned to broad R&D on other sensor systems; and third priority to development of directed

energy weapons with significant promise, including nuclear-weapon-driven ones.*

**Surveillance, Acquisition, Tracking and Kill Assessment (SATKA).** At nearly $1.1 billion in FY89, this budget category includes several hundred million dollars worth of investments in demonstration/validation exercises for boost, midcourse and terminal systems. Although some of the development that supports these exercises is certainly worthwhile, their overall objectives are, as discussed above, premature.

The primary tasks undertaken in this program element should be three: provision of radars for a functional prototype terminal defense; execution of vigorous discrimination research; and R&D in relevant sensor technologies, conducted in synergy with similar work supporting national intelligence assets. The radar task follows directly on the path begun by the Army-supported Sentry radar R&D in the early 1980s, but using the better power sources and computational capabilities since developed.

Midcourse discrimination research under the SDIO has been hampered by two factors: too much support for neutral particle beam development (see the following subsection) and, more importantly, the pressure to move to a Phase I SDS, which forced an optimism about the capabilities of infrared/optical passive discrimination measures. Early on in the course of SDI, the consensus of long-time workers in ballistic missile defense was that passive measures would not suffice, and could be used at best to provide a modest level of bulk filtering of particularly extensive threat clouds. Considerable work has since gone into developing and testing sensors, particularly infrared ones, against known test vehicles, and some public pronouncements have suggested that the prospects for success were surprisingly optimistic. Yet I know of no DOD review body whose opinion about the long-term prospects of passive sensors has agreed with this optimism; the initial consensus remains the consensus. In addition, nuclear precursor countermeasures could be effective against passive systems that might otherwise work. Similarly, extensive debates in the literature about the precise difficulties involved in giving decoys the same thermal and dynamical properties* as RVs have largely missed the key

* This recommendation is not posed as an argument against future changes in the Threshold Test Ban Treaty.

* Cooling rates in the first case; wobble and nutation frequencies in the second case.

point about offensive countermeasures. An offense responding to such discrimination effort would not attempt to make decoys look like RVs, nor the converse. It would be most likely to devote its efforts to making every one of the hundreds of thousands of objects in space look distinctly different from all the others. In such a threat environment the precise signatures observed in Soviet RV tests could have little meaning, as would techniques based on comparisons normalized to such signatures.

Mid-course discrimination is a problem complex in both its technical and its military aspects. Deciding which objects are actually RVs is the most difficult single task, but it cannot be accomplished in isolation. All of the objects must first be located; then, after discrimination is performed, their precise locations must at some point be handed off to the weapons systems that attack them. These tasks must be accomplished without putting into space objects that are too numerous or too valuable (either in cost or as targets) to be practical; and they must be accomplished in ways that do not require unrealistically complex communications or computations.

**Directed Energy Weapons (DEW)** Changing fashions have taken a considerable toll in the progress toward attainment of an actual military capability using directed energy weapons. Chemical lasers, the most intensely funded and promoted before SDI, first fell in importance, and now have recovered to assume a prospective role in the Phase II architecture. Excimer lasers rose while chemicals fell, attaining first priority among DEW as a high-risk, ground-based option; before an evaluation of their success in that role, they were replaced in it by free electron lasers (FELs). Recent SDIO funding actions suggest that FELs, too, have lost their place among the priorities, and might be decelerated as rapidly as they were accelerated.

The susceptibility to direct attack of space-based chemical lasers in low orbits looks just as lethal now as it did when they were deemphasized in the early years of SDI. And the possibility of developing very high-brightness chemical lasers, allowing them to be put out of easy reach of direct-ascent interceptors, seems remote given the last decade's history of development difficulties. They should be eliminated from consideration as weapons for ABM systems.

Work on neutral particle beams (NPB) should be reduced to a small program of accelerator R&D. Both survivability and system size and complexity issues have plagued proposed NPB discriminator schemes and have not received adequate answers.

Currently there is a large program to develop a multi-megawatt free-electron laser at White Sands Missile Range. This project should proceed at a physics and technology-limited pace - or until experimental evidence demonstrates either that the laser will not produce requisite beam and power characteristics, or that the beam will not propagate through the atmosphere. Because either of those failures remains possible, and in fact might not be evident until the White Sands facility begins operation, a back-up development program in excimer lasers is appropriate.

Optics development programs should be structured to support these two classes of ground-based lasers, including the atmospheric compensation techniques necessary to assure propagation.

**Kinetic Energy Weapons (KEW).** First priority in this category should go to the development of the terminal nuclear interceptor to form the basis of the functional prototype system. The existing HEDI project, with some modifications, can serve this purpose. Second priority should then go to development of a longer range ground-based exoatmospheric interceptor, currently the ERIS program. Finally, the space-based interceptor program should be reduced to technology development for small, smart interceptors to see just how small and how smart they can be made. Some SDIO projects are currently working in this direction, but the large development program aimed to support an early Phase I deployment is counterproductive.

**Systems Analysis and Battle Management (SA/BM).** Large expenditures under this category for engineering the Phase I SDS are premature and can be saved. Similarly, the enormous investment in computer simulations at the National Test Bed is unnecessary. Emphasis in this category should be given to more generic work; i.e., promoting the development of the various system elements - communications devices, components, technologies, protocols and software, plus battle management protocols and software. Such developments will be necessary for the functional prototype endoatmospheric defense; they could also support the

more advanced exoatmospheric discrimination schemes (and their associated attack mechanisms) under development, and might eventually support DEW systems. This category should also promote Red Team work to test limits and potential vulnerabilities of battle management systems.

**Survivability, Lethality, and Key Technology (SLKT).** As with the other program elements, this one is currently making large expenditures specifically directed toward the space-based Phase I SDS, particularly in survivability, space launch, materials and power-supplies. Yet advanced R&D for survivability of space-based sensors benefits virtually any concept of a future strategic defense, as well as benefiting national intelligence assets. The same may be said of power and power conditioning research directed to support the technologies already discussed. Lethality work for both interceptors and DEW remains profitable. However, the wisdom of large contributions from the strategic defense budget toward the development of space transportation seems problematic at the present. Provision of inexpensive and reliable space transportation is a national problem that should be addressed with appropriate priority on its own terms, rather than as a tax on strategic defense R&D.

**Department of Energy (DOE).** This supports continuing R&D to better understand the basic science of nuclear-driven directed-energy systems, particularly the nuclear-pumped x-ray laser.

## CONCLUSION

A high-quality and balanced research and technology program in strategic defense that is consistent with the ABM Treaty is in the security interests of the United States. It is my technical judgment that compliance with the Treaty will pose no harmful technological burden on a properly structured U.S. program for the coming decade. A program on strategic defense will be more likely to achieve its goals of determining what advanced technologies look promising and what systems concepts look practical if its research priorities do not put premature emphasis on large-scale technology demonstrations in space. $3 billion is fully adequate to support the program with the research strategy and funding priorities outlined above.

Mr. DELLUMS (PRESIDING). Thank you very much, Dr. Drell, for your opening remarks.

We would now yield to Dr. Codevilla for his opening remarks. You may proceed in any fashion you choose, sir.

## STATEMENT OF DR. ANGELO CODEVILLA, SENIOR RESEARCH FELLOW, HOOVER INSTITUTION, STANFORD UNIVERSITY

Dr. CODEVILLA. Thank you. I have submitted my statement for the record.

Mr. DELLUMS. Without objection, the full text of both gentlemen's statements will appear at the appropriate point in the record.

Dr. CODEVILLA. I am going to present to you a way—not so much programmatic recommendations, although I would be delighted to do that, too—but a way of thinking about the things that we are looking at that differs dramatically from that which Dr. Drell has given you.

My remarks are premised on the fact that you are going to have to make some definite choices about the future, not just of the SDI program, but of ballistic missile defense and more important, of American strategic policy. These choices are not for the far future. They are choices that you are going to make—willy-nilly, consciously or unconsciously—with every action that you take. My belief, which I will try to demonstrate, is that every one of these choices will be terribly significant, because ballistic missile defense is really the only thing that this country can do for itself to get out of a bad and worsening strategic situation.

First, the need for ballistic missile defense predates the Reagan administration. If anything, President Reagan's reassuring image has masked the reality of a ballistic missile threat that is growing out into the indefinite future. Second, the SDI does not exhaust the technical tools and managerial approaches to defending against ballistic missiles. Rather, it is a very peculiar way of using, or rather of not using, many of the resources at this country's command. Therefore, it is the U.S. Government's responsibility to decide how to deal with the threat posed by Soviet ballistic missile forces. The solution need not limit itself to the intellectual horizon of the SDI program.

The questions that are normally asked about SDI obfuscate the nature and immediacy of the choices you face. Let me show you how to get to the heart of the matter.

Should we go ahead with SDI, hold it steady, or cut it back? Well, to decide about this question you have to ask yourself why we want ballistic missile defense in the first place?

It is not so much a question of how much you are going to spend as it is of why you are going to spend any money at all.

If you do not believe that we have any threats to deal with in the near future, why then you may very well want to prepare for threats that might be coming down the road in the year 2000 or later.

But if you believe that there are threats that we must deal with right away, you will have a far different perspective.

I believe, and I will try to demonstrate, that in fact we have need for ballistic missile defense. My own perspective is that it is better to cut funds for SDI but to make sure we actually get some antiballistic defenses than to spend a lot of money with premises and procedures that ensure we will get nothing for the money that we spend.

Second question: Should we tamper with ours and the Soviet Union's mutual vulnerability, which is said to have maintained the peace for all these years?

Well, I think those of you who have looked at the details will agree with me that there is no such thing as mutual vulnerability.

First, as regards civilian targets, the Soviets have never targeted our civil society. We used to target theirs. We no longer do so civilian vulnerability is theoretical. The most-pressing question is the military vulnerability of both sides, and the vulnerability of the civil population to stray rounds or to so-called collateral effects.

There we are in very bad shape and our condition is getting worse. The Soviet Union has from the very beginning built its forces primarily to take out our own missile forces. A decade ago they had about 4,000 counterforce warheads which was about one for every two American strategic targets. Now they have about 6,500, which is about one in three.

If the proposed Star Treaty goes through, that ratio is going to worse for us. They may have five, six, or eight strategic warheads for every target on our side.

How are we going to deal with that? What would happen to the United States if the Soviets exercised their counterforce option? We would have some 2500, roughly, strategic warheads left, aboard submarines. How would we target them?

No one has a very good answer to that question. Moreover, the Soviets counterforce missiles area preboost phase ballistic missile defense, which provides a basis for the operation of their later phase ballistic missile defenses. These are by no means insignificant.

You have heard that the Soviet Union has a defense system around Moscow. It is supposed to consist of 100 launchers.

Well, these launchers, as you know, are capable of launching more than one missile. We have seen that happen with some rapidity. We do not know how many anti-missile interceptors each launcher can fire quickly. But, we can reasonably surmise that they would not have gone through the trouble of making an easily reloadable system, without making that reloadability significant.

Hence, we can expect to have a multiple of 100 interceptors launched from Moscow. We do not know what the multiple is.

Nowadays, we also should not be thinking of this defense as limited to the Moscow area, because, given the increasing ability of the Soviet Union (and indeed of the United States,) to track missiles reasonably accurately from the very beginning, it is increasingly possible to release anti-missile interceptors early on, and therefore to cause the intercepts themselves to occur at very high altitude. This in turn means that the footprint of any defensive interceptor is increased. Therefore, the footprint of the Moscow system is very likely to include a very large portion of European

Russia especially given that the SH–4s are being replaced by SH–11s, which employ optical guidance.

Then there is the fact that the various elements of the transportable ABMX–3 system are in full production. We do not know where these items that are being produced are going, nor do we know their readiness.

We do not know how long it would take for them to go from storage to operational status. Nothing in the treaty or in the laws of God or man prevent that time from being measured in microseconds.

In addition to that, there is a weapon called the SA–12. This is a surface to air missile system. It has some capacity against ballistic missile re-entry vehicles. It was originally designed against, we believe, the Pershing 2. It does a much better job against SLBM reentry vehicles than it every could against the Pershing 2 and it has some capability against fast re-entry vehicles as well.

Then there is an awful lot of construction devoted now to the PVO, which is the Soviet Union's air, missile and space defense organization, the meaning of which is not at all clear to us.

You have seen pictures of the Dushanbe complex. There are many, many theories as to what it means. I have heard them all and they sound reasonable as well as ominous. But there is no basis for us to choose among them.

All we know is that the PVO is an operational organization, not primarily a research organization, and that all this construction—never mind the procurement of anti-missile devices, represent a heavy commitment to ballistic missile defense, a heavy commitment which is paying off.

What do all of these things mean to a U.S. retaliatory strike of some 2500 warheads?

How would we target 2,500 SLBM warheads against these defenses? The answer is not encouraging.

All of this is to say that the Soviet Union's vulnerability, military vulnerability and for that matter, civil vulnerability, is decreasing.

The Secretary of Defense, in his 1988 posture statement, said that, quote: "Left unchallenged, these trends will remove an ever-increasing portion of the Soviet target base from U.S. retaliation."

Now, the fact is that we are not challenging those trends in any meaningful way. Could we do so? Indeed we could. But the principal way of doing it would be to build U.S. anti-missile defenses.

Now, to the question of how feasible U.S. anti-missile defenses are. Feasibility, gentlemen, is a matter of opinion. Feasibility is a judgment, a guess that we make about things that do not yet exist.

Feasibility is a guess about the chances that something will work or will not work. We really never know about feasibility until we try. The question before us is whether we are going to try to build anti-missile devices.

Anyone who stands before you and tells you that he knows, that studies that prove how a future weapons system will perform or will not perform, is not telling the truth. He does not know because there is no way of knowing how things will work until they are tried. He is only persuading you not to try.

Some of you are old enough to remember the ballistic missile program, and how at the beginning of the ballistic missile program the accuracy of guidance systems was a very, very large unknown.

That is why four separate guidance programs were begun, all working according to different principles. They all happen to beat the requirements.

Perhaps none of them would have. Perhaps only some. But they all happen to beat them.

But the outcome is only of secondary importance. The important thing is that we did not know how good the guidance was going to be, but we made a prudential judgment to go ahead and to try to make it as good as we could. It happened to work.

Dr. Drell said that the SDI program has been burdened by the requirement to deploy anything at all as quickly as possible. That I would suggest is precisely the reverse of the truth.

In fact, in 1983, the directions that went to the Fletcher panel, and which the Fletcher panel followed religiously, mandated that no attempt be made to build any defensive device. I must say it broke my heart to see them do it.

SDI began by defining success in an outrageous way. A mandated success rate of 99.75 percent does not have a concrete meaning in practice, because such a definition depends on a load of assumptions about what an attack would look like, what weapons would be employed, etc. But it makes sure no one will actually build anything.

This consequence was also the result of defining the things to be done in ways that made it difficult to do them.

Let me give you a couple of examples.

First, the SDI program has officially defined the hardness of missiles unrealistically. How hard are the missiles to be defeated? The only tests that have ever been carried out say very clearly that solid fuel ballistic missiles blow up, having received a flux of 1,000 joules per square centimeter. That means 1,000 watts per square centimeter per second; and liquid fuel missiles blow up having received one-tenth to one-fifth that amount.

Now, then, the Fletcher Panel defined the missiles to be killed as having been hardened to 100,000 joules per square centimeter.

Why did they do that? Is the United States building missiles that have that sort of resistance? No. Is there any evidence that the Soviet Union is building missiles with such resistance? No.

Let me give you another example with regard to decoys. The ability to discriminate between warheads and decoys is and always has been and always will be a key issue.

In 1958, 1 year before the Thor became operational, 1 year before the United States had a ballistic missile, as the Thor was flying its first test flights, the United States' prototype of the Zeus radar tracked the incoming re-entry vehicle and debris and was able to discriminate between the two sets of things very well.

However, a judgment was made by eminent scientific review committees that this radar would be incapable of discriminating warheads from sophisticated decoys.

Now, of course, that judgment was absolutely correct. But the fact is that the decoys did not exist, were not then in the process of being engineered and in fact did not show up in the arsenal of the

United States or of the Soviet Union until about a dozen years later.

The result of that judgment is then that the United States denied itself a workable, reasonable answer to the ballistic missile problem of the time because that answer could not be for all time.

I suggest to you that that is what is happening today, and what could very well happen 20, 30, 50 years from now. If we allow our definitions of the threat to outrun our ability to outrun the threat itself, and if we allow ourselves to chase, in effect, our own tails, we will never catch those tails. We will be doing research and development forever.

This, by the way, is not peculiar to the strategic defense program. This way of thinking has been applied to a variety of other military programs and has resulted in the proverbial $7,000 coffee pot, which is not so bad, after all, not nearly so bad as the $1/2 billion B-2 bomber.

So long as we keep on conducting R&D in this manner, we will get such results: too late to be useful, too expensive to be built.

Today, by the way, I heard for the first time from Dr. Drell that the latest thought on decoys is random decoys. Of course they don't exist. Neither did the next to latest thought—the balloon decoy, that is to say, the notion that the Soviet Union would enclose both warheads and decoys inside balloons which would look the same to both radar and to infrared detection.

No one has ever made a balloon decoy, launched it, spin-stabilized the warhead inside of it just as if there had been no balloon attempts.

No one has made random decoys either. Reality tells another story about decoys. The Queen Match program, flying out of Alaska, can now discriminate very well in the IR spectrum between warheads and decoys from Soviet tests. The Cobra dane radar can measure the pitch, roll and yaw of warheads and decoys so precisely that we have absolutely no problem telling them apart. So we have two adequate technologies for exoatmospheric discrimination.

Now, the question is, shall we go with what we know and what we can do? Or shall we go after that which we cannot do?

Dr. Drell said that no DOD review body that he knows of believes in the long-term prospects of infrared discrimination.

Well, I am sure he is correct. However, that depends very significantly on the composition of the review body and on the definition of what long term is and what is likely to happen in the long term.

I suggest that a far more sober way of gauging the character of Soviet technology is to trust to intelligence and to reasonable inference or if we must go farther to look to the programs that we ourselves are running and not to create for ourselves specters that immobilizes us.

Time schedules. When can things be done? Well, again, some of us are old enough to remember the ballistic missile program and the Moon program. Things were done much more quickly then because they were done very differently than we do them today.

When I first came to Capitol Hill, my very first job was to run a staff-level hearing on the request by the black side of the U.S. Air Force, 4C 1,000, for a faring to launch a particular intelligence sat-

ellite on top of the Atlas Aegena rocket. The Air Force at the time was asking some 3 years and $300 million.

I scratched my head and remembered that it took about that time and about that amount of money to engineer the Atlas in the first place—at a time when we did not know very much about some fundamental questions, including fluid dynamics at those pressures.

Well, the General sitting at the table showed me that the schedule, for developing the faring including preliminary, critical and final design reviews, the various steps in the DSARC process, required that the contractor's time and personnel be tied up for a certain amount of time, that certain standards be met and that by golly it would take 3 years and $300 million to get that faring.

Well, if we do things like that, we ought not to be surprised about time schedules being drawn out and costs being very high.

What shall we do with SDI in a financially constrained environment?

The real question is not how much money there is to spend overall, but how to spend whatever money there is. There is literally no natural limit to the amount of money that could be wasted by pursuing SDI as laid out by the Fletcher Panel or, if I may say so, by my friend from Stanford.

On the other hand, if the President and Congress really wanted to build anti-missile defenses, even very small sums would buy some actual defensive devices. Even very small sums would give us a lot more than we are likely to get by doing things more or less as we are doing them now.

Recall that we have spent some $17 billion so far under the label SDI. We have spent 6 years since President Reagan first went on television on the subject.

Now, 6 years is one and a half times as long as it took to fight World War II, during which time we built the atom bomb, 100 aircraft carriers, and enough material to overwhelm the world. But 6 years of SDI have produced nothing.

Six years is almost as long as it took to go to the Moon from scratch. During these 6 years the Soviet Union has turned out any number of anti-missile devices. Yet we have spent $17 billion and can defend against precisely nothing. If I were an elected official I would not care to defend spending money this way before the people who elect me. But then again, I am not an elected official.

Mr. DELLUMS. If you were, we could have a good debate.

[Laughter.]

Dr. CODEVILLA. Well, I can tell you that my son goes to Berkeley and that he has debates like that all the time.

So what could we do for ourselves?

In a nutshell, we could do at least what the Soviet Union is doing. We could take those old Spartans and Sprints out of mothballs. We could fit them either with their old guidance systems and their old warheads—of course, their old warheads have been cannibalized—but we could put other warheads on, because they are perfectly good boosters.

On the Spartans we could put the new ERIS guidance system. That guidance system will function with any booster at all. It has functioned quite well with an old Minuteman-2 booster.

On the old Sprints we could put the new HEDI guidance system. If we really want to, we can build new boosters for HEDI and ERIS, but it is not absolutely necessary.

We can upgrade the PARCS radar at Grand Forks, which by the way is a heck of a lot more useful to this country than anything that we could possibly have at Kwajalein.

After all, if the Soviets choose to attack the United States, our having anything at all at Kwajalein is not going to do us any good. Should there be an accident, having something at Kwajalein is not likely to do us very much good unless the missile takes a really peculiar trajectory.

How many Spartan sprint type interceptors should we build? That depends on how much money we have. But we would have a lot more if we did not build them according to current procedures.

We could also duplicate the Soviet SA–12. We can do that very easily and get a much better product. We have an S band radar in this country called the Aegis. It sits aboard ships, does a very good job, can track over 200 targets simultaneously. It could be reconfigured for land transport aboard trucks. It could be married up with any number of interceptor boosters, with the HEDI guidance system.

How many? Each copy of the radar will cost about $50 million. How many do we want?

We could also have a space-based laser. Those of you who are familiar with the history of this program know that in 1980 the Defense Advanced Research Projects Agency submitted to the Senate a plan which would have had a space-based laser flying in November of 1986. That plan was broken up and, interestingly enough, one of its parts, Talon Gold, which was supposed to cost $400 million has been delayed and SDI-isized—I do not know what the right verb would be—so that it will now cost around $1 billion and of course it will be ready in 1990, but it will be much less useful. It will not be nearly what it would have been.

The space-based laser program is now called Zenith Star. It is behind schedule and has suffered the same troubles as Talon Gold. Could Zenith Star defend itself? Well, yes, depending on how you define the problem of defense.

If you define the problem of defense as the American physical society did, that is by stipulating that the laser would have to destroy every warhead coming toward it, the answer is no.

But if you define the problem of self-defense as the laser shooting at the boosters rather than at the warheads that come toward it, the answer is definitely yes.

How adequate would Zenith Star be against missiles? It depends on the distance. It depends on the number, not so much on the power of the Zenith Star Station we would deploy. High brightness lasers are necessary only if they are far away.

One of the basic laws of physics is that the power on target of the laser is inversely proportional to the square of the distance. Bring them closer, and you have a disproportionately high effect on the brightness that is delivered onto the target.

Well, I have spoken long enough to give you an idea of how different this way of thinking about the subject is from what you have heard before.

This year you are going to be deciding on the Accidental Launch Protection System (ALPS). There is an OpEd piece that I had in the Wall Street Journal in back of my prepared statement.

The point of it is, that as you decide on a system, you will have to decide about radar coverage, because there is no natural amount of radar power associated with ALPS, and what kind of radar coverage you decide on will make an enormous difference. It will make the difference between having a token thing and something that actually works.

You will have to decide whether ALPS also ought to have the support of the airborne optical system, which is a kind of infrared, missile-oriented version of AWACS.

You will have to decide whether the launchers will shoot once or many times, et cetera. You will see that the ABM Treaty has virtually nothing to do with the choices before you.

As you will see from my prepared statement and as you can see from what the Soviet Union is doing, it is true of the ABM Treaty as it was true of the arms control agreements which that Walter Lippman commented during World War II. Namely, that disarmament has been terribly effective in disarming those who wish to be disarmed.

Thank you for your attention.

[Statement of Mr. Codevilla, with the attached newspaper article, follows:]

PREPARED STATEMENT OF DR. ANGELO CODEVILLA

STATEMENT Before the Committee on Armed Services
House of Representatives
Strategic Defense: The Imperative to Choose
March 21, 1989
by Angelo M. Codevilla
Hoover Institution
Standford University
California 94305

The well-known troubles of SDI Program has led many to plan for its long-term containment, or for its rollback. But it would be a mistake to believe that the increasing unwillingness or inability of the executive branch to make a persuasive case for the SDI Program, as well as that program's internal contradictions, relieve anyone from the responsibility of making fundamental choices about anti-missile defense. In fact, these choices cannot be escaped.

In a nutshell: FIRST the need for defense against ballistic missiles predates the Reagan administration. If anything, President Reagan's reassuring image has masked the reality of a ballistic missile threat that is growing out into the indefinite future. SECOND, the SDI Program does not exhaust the technical tools and managerial approaches to defending against ballistic missiles. Rather, it is a very, very peculiar way of using, or rather of not using the resources at this country's command. THEREFORE, it is the U.S. government's responsibility to decide how to deal with the threat posed by the Soviet missile force. The solution need not limit itself to the intellectual horizon of the SDI program.

My purpose today is to specify the choices that the Congress will surely make in the coming year. I hope you will make these choices deliberately, after public consideration of all the consequences that each alternative implies. Or you may make them by less responsible means. But, whether by commission or omission, you will make choices that the whole country will have to live with, and for which the country will hold you responsible.

The following is a brief sketch of the choices you face. For a fuller treatment see my book While Others Build (N.Y. MacMillan 1988) and my articles in Commentary of May, 1986, September, 1987, and November, 1988, as well as an article in The Wall Street Journal, January 12, 1989.

Herein I will state key questions as they are commonly posed, and then refine them so as to bring out the stark character of the choices you face.

1. Should we go ahead with SDI, hold it steady, or cut it back?

As it stands, this is a meaningless question. The SDI program is not an end in itself. Nor is it a definite, much less an immutable, set of plans. Since 1986, the SDI program has changed substantially in its premises, focus, and approach. You can shape it as you wish. But to do that responsibly, you have first to decide why you want it at

all.

There is only one reason why the American people care, or why you should care, to spend money in the field, namely to protect ourselves, our armed forces, and our allies against ballistic missiles. Either you share your constituents' desire for protection against ballistic missiles or you are satisfied with our complete vulnerability to ballistic missiles. Regardless of how much or how little you want to spend, if you do want protection, your question must be: "What anti-missile devices can we order now? Who is ready, willing and able to provide them? Secondarily, you will also ask what intellectual premises, focus, and approach will make it most likely that future anti-missile devices will come along faster and for less money? In other words: if you want protection, you want as many actual devices as you can get for whatever money you are willing to spend. It is not so much a question of how much you spend, as it is of the purposefulness with which you spend it.

If, for whatever reason, you are satisfied with our complete vulnerability, be honest enough to say so, and to oppose defenses on that ground rather than by supporting SDI funding the way a rope supports a hanged man. It is better to cut funds for SDI than to push premises and procedures that ensure that we will get nothing for the money we spend.

2. Should we tamper with ours and the Soviet Union's mutual vulnerability, or continue to trust in what has preserved the peace for a generation?

This question is based on false premises. We have had peace in part because the Soviet Union has known that it did not have the option of fighting, surviving, and winning a war against us. Two decades ago vulnerability was not mutual. We could destroy the Soviet armed forces and they could not destroy ours. Whatever Soviet intentions might have been, the Soviets did not have enough counterforce missile warheads to substantially disarm us, nor did they have enough anti-missile devices and shelters to render irrational a U.S. retaliation. But that situation has changed. Moreover, despite the rhetoric about the end of the cold war every bit of intelligence we have about Soviet strategic forces shows that the changes are continuing. Today, any number of people can lay out more or less rational Soviet plans for a first strike against the U.S. But no one in the U.S. military or anywhere else has a reasonable targeting plan for using the roughly 2,500 (mostly submarine-launched) warheads that would be left to the U.S. after a Soviet first strike. In other words, Soviet anti-missile defense begins--indeed largely depends on--counterforce strikes. We might call it "pre-boost phase defense." If any member of this committee would care to suggest a targeting plan that it might be to our advantage to execute after a Soviet first strike. I would eagerly take notes. In sum, the condition of mutual vulnerability is fast disappearing--but on one side only.

The question for us is not whether we want mutual vulnerability. On one hand, neither we nor the Soviets target civilians. On the

military side of things, the question is whether we will continue to accept an ever-more unilateral vulnerability.

The facts are unambiguous. Whereas a decade ago the Soviets had only about 6,000 warheads with the necessary combination of yield and accuracy to destroy U.S. strategic forces, today they have about 6,500 and the number is rising. Thus we have gone from about two Soviet ICBM warheads for every American missile silo, bomber base, command and control center, and submarine port to roughly three such warheads pointed at each of these American targets. Of course the Soviets have about 3,000 other warheads in reserve aboard submarines.

On our side, with the arrival of the Mx, the number of warheads capable of attaching Soviet strategic forces with confidence (and thus reducing their ability to harm us) has gone from zero to 500. But this is only one for every eight Soviet missile silos, submarine pens, etc.

But all of this understates the growing weakness of our position. A decade ago, the Soviet Union's ICBMs were in fixed silos. The then Secretary of Defense, Harold Brown, thought it necessary to acquire 200 mobile Mx missiles, most of whose 2,000 warheads would survive a Soviet attack and threaten to put a big dent into the Soviet missile force being held in reserve for post-attack coercion. This was the heart of the Carter administration's strategy of deterrence. But today that strategy is far beyond our means. Today not only are we unlikely to get more than 50 Mxs in fixed, vulnerable locations. More important, the Soviet Union is taking giant steps toward making even these irrelevant by putting its newest ICBMs, the SS24 and 25 on rail cars and on trucks. In other words, they have moved one lap ahead. Moreover, they have built their best command bunkers so deep as to be invulnerable to any and all nuclear weapons.

On top of all this the Soviets are producing operational anti-missile devices. The conventional formula according to which the Soviet anti-missile system consists of only 100 interceptors for the defense of Moscow could not be more misleading. There are 100 underground ABM launchers around Moscow. Each can fire more than one interceptor in rapid succession. How many and how fast no one in the West knows. But why would they have gone through the trouble of building multiple-fire launchers unless they could launch, say, ten from each launcher? So we realistically have to plan on many hundreds of interceptors. Next consider their coverage. Modern I.R. detection and tracking of ballistic missiles from geosynchronous orbit is accurate enough to allow commitment of interceptors while incoming warheads are still far out in space. That means that interception can take place at very high altitudes. We know the Soviets have the optical guidance systems for accurate, high altitude intercepts because one of their spies, James Harper, stole much of the Homing Overlay Experiment technology from us. We know that the Soviets are deploying SH-11 interceptors equipped with optical guidance to replace their older SH4s. The higher the altitude of interception, the bigger the footprint of coverage. In other words the Moscow system may well give an overlay of protection to much of European Russia.

Then note that the Soviet Union is producing unknown numbers of SH-8 and SH-11 interceptors, as well as unknown numbers of the Flat Twin and Pawn Shop radars associated with them. We do not know where they are being stored or how long it would take to make them operational. As some of you know, all this equipment is transportable, and needs no concrete. The nationwide radar base for a nationwide deployment already exists: nine Pechora class radars are either complete or nearing completion.

Then there is the SA-12. This is a mobile, self-contained surface-to-air interceptor system that is effective against both aircraft and ballistic missile warheads. If the past is any guide, the Soviets will have a production run of about [illegible]00 units, carrying perhaps 4,000 interceptors. It is sobering indeed to factor 1,000 mobile SA-12 units into the targeting plan for a U.S. retaliatory strike.

Then consider some developments about which we have little information. The Soviet Union is full of military construction associated with the ABM program such as that at Dushanbe--construction the substance of which we do not understand. Then there is a variety of Soviet laser programs that can't be discussed in open session. But the very fact that the air, missile and space defense force, the P.V.O. is the fastest growing part of the Soviet armed forces tells us everything we need to know about the Soviet Union's commitment to its own protection.

What is the U.S. government's official word on all this? The 1989 Secretary of Defense Posture statement says: "left unchallenged, these trends will, over time, remove from risk an increasing portion of those [strategic and command] assets which the Soviets consider vital in retaining control over their society and achieving their wartime goals."

Are we seriously challenging these trends with offensive weaponry? No. The Mx is not being given the numbers and mobility of the SS-24. The Trident II will lack both numbers and command and control. Most important, the building of American counterforce missiles is not just too little. It is too late. Killing Soviet hard-targets was the problem of the 1970s and 1980s. The problem of the 90s is mobile targets. The answer to that lies not in the field of weaponry, but in that of technical intelligence. Alas the U.S. government has been even slower and more inflexible in that field than with regard to defenses.

In sum, then, the choice before us is on the one hand to accept that there will be an ever widening gap between the number and quality of military choices at the disposal of the Soviet Union and of ourselves, or on the other hand to break out of this predicament by building American anti-missile defenses.

3. But what about feasibility? Don't fundamental technical problems stand between us and anti-missile defense?

These questions are based either on fundamental misperceptions or

on a certain lack of candor. The practical question at any given moment is what to do (or not do) with the fruits of research that has already been completed. At any given moment, some anti-missile measures will be feasible and others not. Feasibility is a matter of opinion: we cannot know what is feasible and not feasible until we actually try to do it. Feasibility is also a matter of definition: the adequacy of anything depends on how much or how little we want that thing. If we want it very badly it doesn't have to be beautiful. Something less than perfect will do. So the practical question before us is: shall we or shall we not use the technical tools at hand to try? That is, shall we build the best anti-missile devices we can? To instead define anti-missile defense as research into things we cannot do is to say 'no' willfully, but covertly. Since this is a large subject, I shall sub-divide it.

a. The role of will.

The December 1953 issue of Aero-engineering review, celebrating the 50th anniversary of powered flight, contains a prognosis for the future, written by the nation's best-known aircraft and missile experts. Less than four years before the opening of the space age these distinguished gentlemen, who possessed essentially all of the technology that was used in space four to seven years later, did not foresee any of the massive developments that were about to overtake them. Why not? These people were anything but unintelligent. They just were not interested in space. For a variety of reasons, they did not want to go there. There were "space nuts" like Wenner Von Braun. But they were outsiders who got neither prominence nor funding.

The space age did not begin when "technological breakthroughs" came along. Rather, it began when the political decisions were made to shift prominence and funding away from some and to others. I heartily recommend Prof. Walter MacDougall's pulitzer-prize winning history of the space age The Heavens and the Earth (Basic Books, 1985). The lesson of the space age, as Prof. MacDougall shows, is that we do the things we do not because they are feasible, but rather that things become feasible because we want to do them. For example, in 1951 the U.S. government officially decided that ICBMs were unfeasible. In 1954 it decided they were feasible. The technology available had not changed. The definition of ICBM had changed from a rocket that could carry 10,000 pounds 5,000 miles with an accuracy of .01 degrees to a rocket that could carry 3,000 pounds 5,000 miles with half the accuracy previously required. Why had the definition changed? Because intelligence reports told of big missiles being readied in Soviet Central Asia.

b. The tyranny of definitions

Let us see how the practice of defining a priori what is and is not feasible has vitiated American strategic defense from the very beginning. Space permits only a few examples.

First consider a subcategory of this practice called "the responsive threat." The U.S. government says that the "responsive

threat is a reiterative process." This means that a defensive weapon's effectiveness is to be measured not against the offensive weapons that are currently in Soviet hands, but rather against the weapons that we can imagine the Soviets having after they "respond" to our own weapons' development. Furthermore the measure of effectiveness is to be changed again and again to keep up not with changing intelligence about Soviet weaponry but with our own changing thoughts about how the Soviet treat might "respond." In the process, all of the Pentagon's technical communities get to make their contributions. This, by the way, is also how Bradley Fighting Vehicles, and 7,000 coffee pots, and half-billion dollar stealth bombers get designed.

The responsive threat first shot down an American ABM Program between 1958 and 1962. One of the key technical questions about anti-missile systems is whether they can pic out warheads from the decoys and debris that one also re-entering the atmosphere. In 1958, on one of the very first test flights of the Thor IRBM, a year before Thor became operational, the radar of the proposed Nike Zeus ABM successfully discriminated the warhead. But the collective judgment of the U.S. government was that this was not good enough, because the Zeus system could not deal with sophisticated decoys. Note that at that time we did not have any missiles--must less decoys--and that the Soviets did not either. Nor did we have programs for building decoys. In fact, decoys of the type imagined in the 1958 did not become real until a dozen years later. But in 1958 they were real enough as bureaucratic currency to shoot down Zeus. As Robert MacNamara told this committee in 1962: "the tests [of Zeus' performance] by themselves will have little effect on the decision as to whether we will or not proceed into production." Then as since, the decision has been one of preference, not technology.

The story of U.S. ABM Programs since that time has been a cycle: One part of the U.S. government demonstrates the technical capacity of a defensive device (a radar, a pointer-tracker, a guidance system or whatever) to defeat any Soviet offense we know about. Then another part of the U.S. government claims that this device could not defeat a Soviet offense that we do not know exists but can imagine. The Congress and the President then veto deployment of the device, but pay for R&D of an improved device that can meet the "responsive threat." When the new device is ready, the cycle begins all over again. There is a veritable industry at work here, financed by the so-called Defense budget. Perhaps the most striking example of it is Sandia National laboratory. But many thousands of people elsewhere as well who could be productively employed, waste their time and the taxpayers' money this way.

The responsive threat was woven into the warp and woof of the SDI programs. For example, the Fletcher Panel stipulated that the Soviet missiles to be defeated would be resistant to 100,000 joules/cm$^2$ of radiant energy. In fact, solid fueled missiles blow up at 1,000 joules, and liquid fueled ones once they have absorbed only 100 to 500! Moreover, neither the U.S. government nor, so far as we know, the Soviet government is trying to make 100KJ missiles. By using this standard, however, the panel disqualified then-existing programs to

build space-based lasers that could easily defeat any missile ever built or designed.

Another example concerns something called "balloon decoys," an invention of Sandia labs that exists only in Americans' imagination. You see, existing radars are good enough to measure the tiniest pitch, roll or yaw of objects far out in space. That means they really can tell the difference between warheads and decoys. Modern infra-red devices are so good that, even at great distances, they can tell the difference in the termperatures of warheads and decoys. Given this, how could one assert that U.S. anti-missile programs ought to be held back for lack of sufficient capacity to discriminate? Simple. Just stipulate that the Soviets will somehow enclose all warheads and decoys inside balloons that will mask both thermal and radar signatures. The mere formulation of the idea of balloon decoys was enough to start expensive new studies into the concept of "interactive discrimination." Thus do dogs chase their tails.

The SDI Program is also plagued by definitions and requirements made without regard to the "responsive threat." For example, there is a program under SDI called BSTS. It is supposed to develop a means of sensing the three-dimensional location in space of every boosting missile within a meter, and of developing very precise track files on each missile. BSTS would then tell each weapon precisely where to point. This is an expensive, technically demanding program that is also a kind of technical filibuster. We now have in orbit a good IR detection satellite called DSP. It tracks missiles to a rough (but classified) accuracy. We could very well provide DSP with a bit more on-board processing capacity, as well as with the capacity to transmit the information on the rough position of missiles satellites carrying defensive weapons. This would be easy and cheap. The weapon-carrying satellites could use the rough information to point their own sensors. Then they themselves would make the final adjustments (requiring only relative position) and assign weapons. Why not do things this way? The most powerful argument within the D.O.D. in favor of the long, round-about, expensive path and against the short, cheap path is that the latter would violate the ABM treaty. So we spend money--and waste time to buy complexities we don't need because some people don't <u>want</u> to see this job done but would rather not say so openly.

So much depends on how the task is defined. Take for example the following paragraph from the 1987 report on directed energy weapons by the American physical society:

For a nominal hardness of $10kj/cm^2$, at a range of 1000km, the brightness-time product needed is $10^{20}$j/sr. Assuming that the engagement time is .01 seconds (as noted in calculations that follow later in this chapter) a brightness of $10^{21}$w/sr is required... If the mission requires a brightness of $10^{21}$kw/sr, a laser at [a wavelength of one micron] operating with 10m mirror will need to generate about 30

megawatts... at [three microns] 300 megawatts would be required.[8]

English translation: If we assume, without argument, that the Soviet missiles to be killed by U.S. laser weapons are ten times "harder" (i.e., more resistant to lasers) than the hardest missile flying today and if we further assume, again arbitrarily, that we have only one-tenth of a second to make the kill, it then follows that in order to kill missiles the U.S. would have to put into space either a 30-megawatt laser operating at a wavelength of one micron, or a 300-megawatt laser operating at a wavelength of 3 microns. The U.S. does not now have the capacity to produce such lasers, and will not for the near future.

The point of such discussions is to persuade those who do not read very closely not to <u>try</u> to build anti-missile defenses.

Consider also the adequacy of battle management. The Fletcher Panel stipulated that battle management would have to compile "birth to death" files on every warhead, decoy and piece of debris released during a missile attack. The information gathered during boost and post-boost phase would have to be communicated to midcourse systems, and, together with all the information gathered there, would flow to terminal systems. All the information would have to flow simultaneously to a central point on earth where human beings would have to have the power to override any decision made by the system. As the distinguished computer scientists in the Eastport study group pointed out in 1985, this is a recipe for an impossible software system that, were it to be created, would be counterproductive. Far better, said the Eastport study group, to do things as simply as possible. But this is not what the SDI Program has been about.

Do you approve of this way of doing things? Why don't you change it?

c. The obscurantism of scientific review committees

The American political system would not stand for such a grossly wasteful handling of the taxpayer's money were it not endorsed by committees of the "best and the brightest." But it is. As Prof. MacDougall shows in his prize-winning history, the 1960s saw the realization of the fears of a "scientific-technological elite" that President Eisenhower expressed in his farewell address. Robert MacNamara and his Lieutenants established a set of largely self-perpetuating committees to legitimize and oversee innovation. These committees continue to infuse the process of innovation with the preference for "pushing the state of the art" over the expeditious engineering of production models. Ultimately, it neither produces weapons nor raises the state of the art. This scientific bias coincides in practice with the bias against new weapons of those who serve on the committees. The involvement of scientists tends to shield decisions from scrutiny by giving the impression that the decisions are about science--on which few may legitimately speak--rather than about public policy.

Policymakers should recognize the fact that the policy preferences of scientists and engineers inevitably color how they approach a problem. Nothing is dumber than to give charge of something to people who don't want to see it done. Note for example that when nuclear physicists in wartime Germany, led by Werner Heisenberg himself described to their political masters what would have to be done to build the atom bomb, they empasized the enormity of the task. They did not want to do it. By contrast, American physicists--many of whom were refugees from Hitler's Europe, were eager to show how the big job could be done.

It is obvious that the Pentagon's scientific committees--beginning with the Fletcher panel itself--are not at all eager to build anti-missile defenses. Many of their members are political leftists, while others, by both inclination and interest prefer channeling money to research rather than production. Note well that many benefit personally from emphasis on Research. But please realize that it would be child's play to constitute committees of senior aerospace engineers--at least as eminent as the ones who sat on the Fletcher Panel or sit on the Defense Science Board--who would be differently inclined politically, and who temperamentally would tend to recommend production over research.

Where does this leave Congress and the President? Precisely where they should be, that is, in charge. Yours is the power now as it was in the 50s to listen to one group of technologists or to the other. The difference between now and the 50s is that the scientific advisory process is so bureaucratized that you probably don't realize you have a choice. Please remember that respect for science does not mean prefering wasteful and inefficient practices that make no strategic sense.

d. Time schedules

Once upon a time, before the bureaucratization of innovation, the U.S. government and the aerospace industry functioned very differently than they do today. In July, 1955 the NSC decided to produce IRBMs. It took the Pentagon six months to define the Thor, and nine months to define the Polaris, and to let out contracts. Then the Thor contract took 28 months, the Polaris contract 46 months--and the U.S. had operational units. We had this efficiency despite the existence of basic problems in everything from guidence, to computers, to metallurgy, to fluid dynamics, to chemistry.

By contrast. the Mx, which is an extrapolation of old technology, took some fifteen years between the decision to start development, and I.O.C. By contrast also, the Soviets' rough 'n ready version of the Mx, the SS-18, was first deployed in 1977, the SS-18 mod.4 was fully deployed by 1982. The fancy version, the SS-24, deployed contemporaneously with the Mx, took five years to engineer.

The atom bomb began with the S-1 committee's recommendation of the Manhattan Project in May, 1942. Thirty eight months later, some basic scientific and a host of technological problems were overcome and the

Bomb exploded. In April, 1961 John Kennedy committed the U.S. to put a man on the moon before the end of the decade. Eight years later, after building a complex infrastructure from stratch, the Eagle landed.

By contrast, six years have passed since Ronald Reagan talked about strategic defense on March 23, 1983. During these six years the Soviet Union has produced any number of working anti-missile devices. The U.S. has produced none. Not only that. We have not built even a single tool that might turn out any anti-missile device. Of course we are awash with useful technology. We literally have more than we know what to do with. Some of it (HOE) has even been stolen by a Soviet spy and is already in use in the Soviet Union.

How long would it take to deploy this on that system? The various answers bandied about today are not very useful because they factor in the present way of doing things. It is more instructive to ask "how long would it take to develop or deploy system 'x' under the operating environment of 1957-61? Under the operating environment of World War II? What does it take to move quickly? Why have we been moving so slowly lately?

Fast programs are directed to building things. If President Kennedy had directed research into the best possible method of going to the moon, we would still not be there. Fast programs are not run by normal bureaucracies, but by special, single purpose groups run by people who really want to get the job done. Especially when these special groups are off in a courner of larger ones, those who lead them must be willing to earn the undying hatred of the regulars. The U.S. Navy never forgave Hyman Rickover for his success. If the U.S. ever gets a anti-missile defense the Pentagon will never forgive the man who makes it happen. This sort of thing cannot be done without fierce desire and disdain for stepped-on toes. Fast programs flush the system of the unmotivated or incompetent. Fast programs are usually cheaper than slow ones. Time is money. All of this is to say that what passes for technical scrupulosity with regard to SDI is a pseudo-technical process whose main product is to waste money, human capital, and time.

4. What do we do with SDI in a financially contrained environment?

The real question is not how much money there is to spend overall, but how to spend whatever money there is. There is literally no natural limit to the amount of money that could be wasted by pursuing SDI as laid out by the Fletcher Panel, according to the Pentagon's current procedures. On the other hand, if the President and Congress really wanted to build anti-missile defenses, even very small sums would buy some actual defensive devices--a lot more than the country has gotten for the expenditure of some 17 billion dollars on SDI since 1983..

(In fairness, I point out that most of the money spent on SDI was not "new money." In 1983-84 the Pentagon simply took some programs that were already well-established in the Five Year Defense Plan (FYDP), placed the label "SDI" on them, and then modified them--usually in ways that made them less efficient.)

Since 1961, the proportion of the price of military equipment that is due to materials and labor has declined, while the proportion due to the way the individual program is managed has risen. Every penny of the outrageous cost of toilet seats, coffee brewers, and Stealth bombers is fully accounted for by the amount of time that contractors' personnel and facilities were assigned to the programs. That time, in turn, is fully accounted for by the regulations and program directives that the contractor received. That in turn is accounted for by the fact that the various parts of the Pentagon's bureaucracy use the regulations for internecine battles over budget and turf. Especially as regards strategic defense, but in other fields as well, no one has the authority to simply design a system and get it built in a straightforward manner.

My favorite example from the SDI world is the Talon Gold program. Formulated in 1979, TG was supposed to produce, by 1984, a pointing and tracking device that could be literally bolted on to any directed energy weapon in space. Such a thing is absolutely necessary if we are ever going to have space weapons. TG would acquire the target and lock on with a precision of .2 of a microradian--all for 400 million dollars. But by 1982 DARPA began to de-scope the program, removing the acquisition telescope, ostensibly to save money. During a 52 week period in 1983 and '84 the contractor received 52 re-scoping or de-scoping messages. The program virtually stopped while costs soared. In late 1984 TG was canceled. But since it was essential, it was continued under another name, GPT. By late 1985 GPT had become StarLab and consisted of a bare-bones pointing experiment scheduled to ride the shuttle in 1987. The total cost, including TG since 1979, was now scheduled to be some 700 million. After the Challenger disaster, the program was re-defined and stretched to 1990, when, for close to a total of one billion, and six years late, it will produce something far less useful than it would have, had it been left alone and had the term SDI never been whispered.

Even without this kind of internal indecision, the very system of preliminary, critical and final design reviews, and the DSARC process, simply eats time and money. If and when the U.S. government wants to spend the taxpaper's money for defensive devices, it will have to set aside these things. If they are not set aside, the amount of money spent will be relevant only to those who get it or fail to get it. But it will have no bearing on the United States' strategic predicament. As one old timer in the aerospace industry puts it, "we're not dumb. If you pay us to churn out paper instead of hardware, we'll take it to the bank just the same."

The prices often quoted for major systems are 'soft' numbers. They can go much higher or much lower. A lot depends on how you want to do things. How do you want them?

5. What can we do under the ABM treaty?

That depends almost entirely on what we want to do.

Both the U.S. and the Soviet Union can certainly develop and test

any and every kind of surface-to-air system for exclusively anti-missile purposes, so long as the interceptors have single warheads and so long as during the test phase the components are "fixed"--whatever that means. There is no limit to the number of large phased-array radars supporting the system, so long as these are on the periphery of the country and oriented outward. There is indeed a limit of 100 operational launchers, but no practical limit on how many interceptors these 100 can launch, or on how "rapidly" they can launch them. There is no limit on the altitude of the interception or on the sophistication of the discriminaton. There is no limit on how many interceptors or launchers or missile guidance radars may be produced, or on where they may be stored, or on how quickly they may go from a "stored" state to a "ready to shoot" state--nothing in the letter of the treaty prevents this time from being measured in microseconds.

So long as any ABM system or component of it can arguably be said to serve another purpose as well--including the countering of ballistic missiles that are not "strategic," a term not defined in the ABM treaty--there is no restriction whatever in developing, testing or, of course, producing and deploying any of them. The term "ABM mode" has no specific meaning in the text of the treaty. The distinction between air defense equipment and antimissile equipment once had a basis in technology. It no longer does. The distinction between the antitactical and antistrategic missile functions was always a legal fiction. So, either side can build and deploy as many as it wishes of dual-purpose antiair ABM systems, dual-purpose antisatellite ABM systems, and dual-purpose antitactical ballistic missile ABM systems. These can be ground-based, sea-based, or whatever, and of course there is no limit whatever to their capabilities.

As for ABM systems based on physical principles other than radar and chemical-rocket interceptors, either side can build as it talks. In other words, nothing in the letter of the ABM treaty prohibits either signatory from building a good anti-missile defense.

Any of the American negotiators of the treaty would regard the above analysis as nonsense. "Look at the preamble, and at Article I!" Paul Nitze once told me, pounding his fist into his palm for emphasis. "I'm a lawyer, and I tell you that every provision of the treaty has to be read in the light of the reason why both sides entered into the treaty in the first place: to ban ABMs as a significant factor in the strategic equation." Nitze has a powerful point. Leave aside the fact that eloquence in articulating the purposes of legal instruments does not make up for sloppiness in drafting the instruments themselves. Leave aside also that there is no evidence that the Soviet Union entered into the ABM treaty for the purpose of leaving itself undefended against American missiles. The fact still remains that the practical meaning of any provision of the ABM treaty does, in fact, depend almost entirely on the extent to which one is animated by the intention to have or not to have antimissile devices for one's own country. In other words, it depends on what whoever reads the treaty wants to do or does not want to do.

However, this point has two very different implications. If one

intends not to have an antimissile defense, one does not really need any detailed prompting about what not to do. In fact, the U.S. government has woven a web of practical restrictions far tighter than the letter of the treaty requires. On the other hand, if one intends to have a defense, the letter of the ABM treaty is no barrier. As we can see, the Soviet Union has done just about everything I have suggested can be done. And in most cases, we have not called Soviet actions "violations" because the treaty language is in fact broad enough to accommodate them.

When Henry Kissinger presented the ABM treaty to the Senate in 1972 he warned that if either side sought to use the treaty's terms to gain marginal advantage over the other the treaty would fail. That is why Kissinger emphasized the necessity of both sides being animated by the same spirit of renunciation. But of course that spirit is something that the treaty cannot provide. The Soviets have not had it.

In sum, the ABM treaty itself does not prevent us--any more than it is preventing the Soviets--from building an anti-missile defense. Not the ABM treaty, but rather the policy preferences of many people in government stand in the way of U.S. defenses. It would be best for the country if these policy issues were discussed on their own terms.

6. What could we do for ourselves if we wanted to?

That is precisely the question to ask. Here are some answers.

. We could upgrade the PAR at Grand Forks to perform ABM battle management. We could do the same for our three BMEWs radars, and build similar radars on our periphery. We should build and deploy some 20 Airborne Optical Systems (AOS)--a kind of IR version of AWACS. We should take our old Spartan interceptors out of storage, equip them with ERIS guidance systems, and deploy them in connection with these radars and AOS. Old Minuteman II boosters can also be fitted with ERIS guidance. Our old Sprint boosters could be fitted with HEDI guidance, and a high explosive warhead. This would give us a good thin nationwide coverage.

. We could mass produce the Aegis Naval Radar System and configure it for truck mobility. Each Aegis could be accompanied by HEDI interceptors, and provide good insurance for individual targets against as many incoming warheads as we chose. Since these mobile systems--like the Soviet SA-12--could be concentrated unbeknownst to the attacher, the attacher would never know how many or how few warheads he owuld have to use to destroy a priority target. Also, since few if any enemy warheads would get near civilian concentrations, even one of these mobile sytems would be good insurance for a city.

. We have lost much time on space based lasers. If the plan that DARPA presented to the Senate Armed Services Committee in 1980 had been followed, the U.S. could have had a missile-killing laser in orbit in November, 1986. A reoriented, sped-up version of the Zenith Star Program now would take about three years to yield such a missile killing laser. Five years from now we could be orbiting them in

quantity.

. We could build a variety of kenetic fill vehicles for basing in space. Technology has not been a problem for years. Transportation is, and will remain a problem. That is because of the horrid 'expert' decisions that have resulted in the Soviet Union having a first-rate heavy launch vehicle while our own heavy lift-vehicle, the Saturn V, is in museums. Meanwhile the "best and brightest" of American R&D share research money for a new one to fly in the next century.

. What good would all these measures do? They would surely render nonsensical any thought of a preemptive strike against the U.S. Should one occur anyhow, they would defeat it while protecting the American people from the collateral damage therefrom. How well they would do these jobs would depend on the quantity and the timeliness with we pursued production.

The point, gentlemen, is production. the rest is expensive eyewash.

7. A case study of choice:ALPS

As you make your day to day decisions, you will be choosing among the alternatives I have outlined above. One example of this is the set of decisions that is coming your way under the label ALPS. The program may be small. But each of the detailed choices within it is a big choice. With each of these choices, each of you will be deciding whether you share the American people's preference for defense, or not.

THE WALL STREET JOURNAL THURSDAY, JANUARY 12, 1989

# ALPS Could Open the Door to Real Defense

By Angelo Codevilla

Last January, Sen. Sam Nunn (D., Ga.) hinted he might favor deploying up to 100 anti-missile interceptors to protect the U.S. against an accidental Soviet launch, or against one from some hypothetical primitive nuclear power. Such an Accidental Launch Protection System (ALPS), Sen. Nunn noted, would be very much within all interpretations of the ABM treaty. And, of course, enough technology to do such a job has been available for a long time.

Republicans who had labored for a decade to deploy anti-missile defenses put Sen. Nunn's suggestion in the form of an amendment to the annual defense authorization bill. But then all the forces that have been blocking U.S. missile defenses for a generation—chiefly the Air Force, the arms-control lobby and the Democratic Party—rose up to protest cracking open the door that might lead to defense. The administration, consistent with its policy of only researching and not deploying anti-missile defenses, also fought against ALPS. In the end, even Sen. Nunn voted against his own suggestion. The amendment got 37 votes.

### A Foot in the Door

Now the coalition behind ALPS is broadening. At one end are some Democrats who see a deployment of ground-based anti-missile interceptors—so long as it is within the ABM treaty—as a way of putting an end to the clamor for a serious national effort at anti-missile defense. At the other end are the longtime protagonists of anti-missile defense, who were never comfortable with President Reagan's all-at-once-or-nothing approach to the strategic defense initiative. They view ALPS as a foot in the door. In the middle are a growing number of analysts—e.g., Brent Scowcroft and James Woolsey—who want ALPS to defend bomber bases and command links. Others see it as the only protection against Soviet mobile missiles.

Such a coalition might well muster a congressional majority. However, it would shatter the moment ALPS moved from generalities to concrete choices:

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Should ALPS use airborne infrared devices to discriminate between decoys and warheads? The U.S. has not deployed such devices. Moreover, since 1984 it has removed key components from test models to keep within a unilateral U.S. interpretation of the ABM treaty. Perhaps 20 of these infrared versions of AWACs could cover the country for ALPS. But such coverage would also serve a much bigger defensive deployment. The decision about this kind of ALPS sensor would also be a decision about national strategic policy.

2. The same applies to the siting of interceptors. If they were at just one site, or even two, they could cover the entire country only if the missiles were coming in over the poles *and* if they were detected and fired on instantly. To really cover the country, ALPS interceptors would have to be in at least a half-dozen places. They could perform best if they were mobile.

Multiple, even mobile, siting of ALPS would be easy enough, especially if we did what the Soviets do, namely endow certain "air defense" interceptors with the capacity also to strike ballistic missile warheads. The Soviet SA-12 system fills this role. Our naval Aegis radar, if given a fast interceptor (for example, the new High Endo-Atmospheric Direct Intercept [HEDI] missile), could do a better job. But to follow the Soviets down this path is to accept the notion that we ought to use whatever tools are at hand to defend against ballistic missiles. This leads to space-based defenses as well. To reject this path, however, is to make ALPS the end rather than the beginning of a serious defensive effort.

Wherever they are based, the ALPS interceptors must have launchers. But how shall these launchers be loaded? The American interpretation of the ABM treaty calls for launchers to be capable of launching one and only one interceptor. That is why the old U.S. ABM system was loaded in a manner intended to be time-consuming. But interceptors can be reloaded very rapidly. Indeed, we have observed the Soviets doing that. Nor have we called this practice a violation of the ABM treaty. Given automatic reloading, each ALPS launcher might dispense any number of interceptors. That surely would allow for a rapid expansion of U.S. defenses.

Liberals will argue, correctly, that air-defense interceptors that also intercept warheads blur the distinction between air defense and ABM defense that American SALT I negotiators tried so hard to establish. They will observe that reloadability and mobility of ABM equipment make impossible any meaningful limitation of ABM. Conservatives will agree, and ask why we should limit ourselves in these fields while the Soviets have not.

*Right from the start we will have to decide whether the system's mission is to perform real military tasks, or to be a placebo in lieu of the performance of those tasks.*

3. Since the ALPS plan requires some 100 deployed interceptors, there would have to be some kind of production line. We could decide to produce interceptors and associated equipment by the thousands, while deploying only 100, thus making ALPS a step in the direction of a serious defense. On the other hand, liberals may well demand that we produce only as many pieces of equipment as we deploy and then destroy the tooling. But the ABM treaty does not limit how many ABM devices either party can produce. Nor does it say at what point the storage of ABM equipment becomes "deployment." Hence nothing will obscure the fact that the argument over ALPS production will be about the kind of military posture the U.S. should have.

4. Just how big and capable should an ALPS system be to guard against accidental or "third country" launches? The chances of the Soviets accidentally launching any missiles at us, never mind more than one or two, are as negligible as are the chances that we would accidentally nuke Moscow. As for hypothetical missile-armed Third World leaders, they will not shoot at us because they have nothing to deter us from wreaking terrible retribution. No. We don't really need any interceptors to protect against an accidental launch—or maybe only a very few. But to accomplish serious missions, we need a lot more than just a few.

That is why the number of interceptors in the "initial deployment" would be less significant than the national commitment that the number implied. To limit ALPS to 100 interceptors, period, is to value the ABM treaty over any of the missions that ALPS would perform. But if we agreed to exceed 100 because, say, we valued a defense against depressed-trajectory SLBMs more than we valued the ABM treaty, why not start with 200, or for that matter 1,200? Such numbers would provide real defenses of priority targets, as well as real insurance against Soviet "stray rounds" that might miss military targets and get near major cities. Larger numbers would help to deter attack in the first place.

In other words, right from the start we will have to decide whether the mission of ALPS is to perform real military tasks, or to be a placebo in lieu of the performance of those tasks.

5. Now for the bureaucratically hard part. The Joint Chiefs of Staff will oppose ALPS whether it is small or large. If small, they will give it the malign neglect they gave to ABM programs in the '70s. But if ALPS is large, the service chiefs will insist, as they did with SDI, that the system go through procedures and meet standards that will put off indefinitely the dread day of decision about money and mission.

### A 'Unified Command'

The money spent on ALPS will be unavailable for current military programs. None of the services wants to lose money, none wants the ABM mission for itself, and yet none wants the other to get an important additional "mission." The services' solution has been to assign the mission to a "unified command." Anyone interested in delaying ALPS or in raising the cost so high as to discourage more defense will insist on that, and on maximum control for the services over ALPS.

Liberals will be standing four-square behind the military's wasteful bureaucratic rigors. Pro-defense people will argue for giving ALPS the special place that Hyman Rickover's Nuclear Navy enjoyed within the Navy in the '50s, or perhaps for the near-separate status that the Army Air Corps enjoyed up to 1947, or even for a fully independent military service.

For better or worse, these choices—including engineering details—will be made up front, in the legislative process by which weapons systems are authorized. Because this process is largely public, those who are about to engage in the great ALPS debate of 1989 should be equally up front about what they want out of ALPS and why they want it. Those who try to get their way by acting as if ALPS does not pose the most fundamental choices about U.S. defense policy will wind up fooling only themselves.

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THE WALL STREET JOURNAL THURSDAY, JANUARY 12, 1989

# ALPS Could Open the Door to Real Defense

By Angelo Codevilla

Last January, Sen. Sam Nunn (D., Ga.) hinted he might favor deploying up to 100 anti-missile interceptors to protect the U.S. against an accidental Soviet launch, or against one from some hypothetical primitive nuclear power. Such an Accidental Launch Protection System (ALPS), Sen. Nunn noted, would be very much within all interpretations of the ABM treaty. And, of course, enough technology to do such a job has been available for a long time.

Republicans who had labored for a decade to deploy anti-missile defenses put Sen. Nunn's suggestion in the form of an amendment to the annual defense authorization bill. But then all the forces that have been blocking U.S. missile defenses for a generation—chiefly the Air Force, the arms-control lobby and the Democratic Party—rose up to protest cracking open the door that might lead to defense. The administration, consistent with its policy of only researching and not deploying anti-missile defenses, also fought against ALPS. In the end, even Sen. Nunn voted against his own suggestion. The amendment got 37 votes.

### A Foot in the Door

Now the coalition behind ALPS is broadening. At one end are some Democrats who see a deployment of ground-based anti-missile interceptors—so long as it is within the ABM treaty—as a way of putting an end to the clamor for a serious national effort at anti-missile defense. At the other end are the longtime protagonists of anti-missile defense, who were never comfortable with President Reagan's all-at-once-or-nothing approach to the strategic defense initiative. They view ALPS as a foot in the door. In the middle are a growing number of analysts—e.g., Brent Scowcroft and James Woolsey—who want ALPS to defend bomber bases and command links. Others see it as the only protection against Soviet mobile missiles.

Such a coalition might well muster a congressional majority. However, it would shatter the moment ALPS moved from generalities to concrete choices:

1. Since there is no "right" amount of radar power and distribution to service an ALPS, how much should we give it? A single, large phased-array radar located, say, in Grand Forks, N.D., could provide tracking data only on missiles coming from one direction, and most likely not on submarine-launched ballistic missiles (SLBMs). Such an ALPS would be a mere token. But pro-defense people want an ALPS that is serious and is easily expandable. Indeed, the long-range radar base for a good "thin" defense is not much different from that for a good "thick" defense. The best kind of radar base for ALPS would be much like the nationwide network of "Pechora" and "Hen House" radars that the Soviet Union has built. Both sides in the debate would agree that such a base opens the door wide for a serious ABM. If we build ALPS, we will have to decide whether to open that door.

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Mr. DELLUMS. Thank you very much, Dr. Codevilla.

Let me just first say my remark was not attempting to be flippant but simply as a person who is an elected representative for 21 years, we do have to carry another burden. That is the responsibility of establishing priorities. So we cannot look at one item in a vacuum. If we had that luxury, then maybe your point is extremely well taken.

But when we have to address the great myriad of human misery and the panorama of public concerns, this issue is only one item of the issues that we deal with.

I happen to think, without trying to go into a lecture, but just from a defensive posture, that sometimes we get bad rapped. I think that that is a major responsibility we have, is to delicately attempt to prioritize and balance the priorities of this country. That is the one reason why I made my comment.

Dr. CODEVILLA. Yes, sir. Having worked on Capitol Hill for 8 years, I am acutely aware of that and I much appreciate it.

Mr. DELLUMS. Now, just two quick things, and I want to go to Dr. Drell, because he took a few shots in your presentation, give him an opportunity to respond.

Dr. CODEVILLA. Sure.

Mr. DELLUMS. Because I think perhaps the most exciting hearings oftentimes are when the witnesses can exchange among each other and then hopefully as nonparticipants, or participant observers in that struggle, we can learn.

Before I go to Dr. Drell—I had made a note—being an intelligent and bright human being, your arguments follow very logically and very rationally. But I would like to go not to your arguments but to your assumptions. If I am incorrect, let me understand. Because you had made no mention of ABM until the last comment and you said that it has no role.

As you know, there has been over the past couple of years, led by Senator Nunn, et cetera, a very lengthy debate over the narrow versus broad interpretation of ABM.

I frankly thought that was an irrelevant debate and unnecessarily a wasteful use of time because it only focuses on at what point do you abrogate the treaty by virtue of certain tests, and et cetera.

I come to a different conclusion. My basic response is, and I would appreciate it if you would respond to this, that the logic of SDI flies in direct contradiction to the logic of ABM.

Dr. CODEVILLA. You bet.

Mr. DELLUMS. So a discussion over narrow versus broad and when do you violate the treaty with tests is an irrelevant discussion.

The basic decision before this body and before the American people is, if you support ABM how in the hell can you support SDI, or vice versa, and that you need to come honestly to that point.

Dr. CODEVILLA. I could not agree more, sir.

My point was a slightly different one. That is, if you look at the ABM Treaty as, if I may use the term, a shyster lawyer, that is to say, as your average tax accountant looks at the tax law, and ask how much as I can get away with under this treaty?

You will find that you can get away with an awful lot. The finest evidence for that statement is that the Soviet Union has gotten

away with an awful lot that we have, and I think quite correctly, not called "violations" on most of what they have done.

For example, we have not called the SA-12 a violation, because in the ABM Treaty there is no distinction, prohibition or provision for something that has several uses at the same time.

The Soviet Union correctly claims that the SA-12 is a surface to air missile system that shoots down airplanes. It does that. It also shoots down re-entry vehicles—very much within the letter of the ABM Treaty, but wholly outside its spirit.

The Soviet Union has carried this approach a bit far by claiming that the Krasnoyarsk radar is for space tracking. But the U.S.S.R. has a point. The Krasnoyarsk radar can track space objects. Of course, it is optimized for something else. But it can do that. The ABM Treaty does specifically allow radars of unlimited power to be in locations other than the periphery so long as they are for purposes unrelated to ABMs, such as space track. Do you see my point? The treaty means what you want it to mean.

Mr. DELLUMS. I am trying to follow, because I am trying to understand whether you are advocating pushing the limits of the treaty on the one hand or——

Dr. CODEVILLA. I am not, sir.

Mr. DELLUMS. OK. Are you saying to face the issue cleanly, decide whether you want to consciously choose to go forward in such a manner that would abrogate the treaty. Do it up front. Am I understanding what you are saying?

Dr. CODEVILLA. I am saying two things.

One. What you have just said. We must face the issue cleanly. Was the ABM Treaty a good idea in the first place? Is it a good idea for us now? That is the paramount decision that we are facing.

Two, I also made the point that when one looks at a treaty that is drawn as imprecisely as the ABM Treaty is, how you interpret it depends on your will, on the reasons why you went into the treaty in the first place.

The spirit of our negotiators is the reason we entered into the treaty, "thou shalt not now nor ever have anti-missile defenses." Meanwhile the Soviet Union adheres to it—if that is the term you want to use—in a spirit which is very different, in the spirit of the average tax accountant, which is bad for the United States.

Mr. DELLUMS. Having been in Washington for 18 years, I do not think I am naive enough to think that we are walking around with white robes on. I would imagine both sides are pushing the limits.

Dr. CODEVILLA. I wish it were so. But we have an office in the Pentagon whose job it is to make absolutely sure that not only do things not get to the stage of explicit violation, but that they are not conceived in ways which might lead there.

The man who ran that office for many years is named Lee Monichiello. He is very good at his job.

Mr. DELLUMS. I did not say explicit violation. I said pushing the limits, which is different.

Dr. CODEVILLA. No, we do not push the limits. Quite the contrary.

Mr. DELLUMS. Let me go to the second assumption.

As you articulated your notions about missile defense, am I incorrect that one of your basic assumptions is a war fighting assumption?

Dr. CODEVILLA. Sure.

Mr. DELLUMS. How does that relate to the whole notion of deterrence as the underpinning of our—as the policy framework for our military weapons, and are you advocating that we move from a concept of nuclear deterrence to one of nuclear war fighting capability?

Dr. CODEVILLA. As one who enjoys living, and has experienced war, I very firmly believe in deterrence. But as a student of these matters, I also know that deterrence exists in proportion to one's ability to fight, survive and win, should deterrence fail. Deterrence is not a work of magic. It is a calculation. Deterrence, unlike pregnancy, is not an all-or-nothing proposition. Deterrence is proportionate to one's ability to do certain things, and to the other side's ability to do them.

So, any notion of deterrence not based on the capacity to fight does not make much sense to me. I suspect it does not make much sense to the other side, either.

Mr. DELLUMS. Lord Mountbatten's comments that I paraphrase are appropriate at this point, and he said before he died that, "I have come to the realization that nuclear weapons cannot be counted as military weapons because of their heinous capacity to destroy human life, and that what imperils human life on this planet is in the illusion that they can be used." You talk about nuclear weapons as if they are like M-1 rifles because you even said stray round.

Dr. CODEVILLA. That is correct.

Mr. DELLUMS. You are talking about a nuclear weapon explosion that could damage the earth's ozone, that could threaten the food chain, that could wreak havoc on the planet. We are not talking about a stray shell dropping. We are talking about the capacity to destroy human life beyond comprehension. We are not talking stray shells.

Dr. CODEVILLA. Carthage was totally destroyed, wiped off the face of the earth by fire, sword, and Roman plows, followed by soldiers spreading salt to poison the earth. Hiroshima is now a thriving city.

Consider precisely what we know, not what we suspect or fear, but what we know nuclear weapons do. Every targeter must ask himself where he should shoot and not shoot what should be destroyed or spared—the question is no longer, "Should we nuke Moscow," but should we choose to shoot in that direction, where shall we put our 4 or 5 square mile circles or 10 square mile circles of destruction in an area that is roughly 2,500 square miles. Where you shoot makes a difference. That's where people die.

Robert McNamara's premise when he defined mutual assured destruction as the capacity to kill 25 percent of the opposing side's population and 50 percent of its industry was that the world would end and there would be no questions to be asked on the day after.

But the moment people began to think about what that meant, they realized that it did make a difference who lived and who died, even if that monstrous scheme was put into operation. That it did make a difference, and that perhaps 175 million surviving Russians would think of something for the day after.

Fortunately or unfortunately, for better or worse—nuclear weapons are not buttons which, if once pressed, relieve us of all further choice. So it does make a difference how these things are used.

Mr. DELLUMS. I would like to come back to you a little later. I want to give all my colleagues an opportunity. But Dr. Drell, I would like to give you an opportunity to make some comments at this time.

Dr. DRELL. I think Carthage is irrelevant to what we are talking about today. When Carthage was destroyed, there was a whole world out there to rebuild it, just like Hiroshima had a whole world out there to rebuild it. I think your comments are quite pertinent on the subject of a nuclear war.

As to the compatibility of SDI and the ABM Treaty, I think the ABM Treaty is the most important achievement in 20 years of arms control, and I think the right SDI program is quite consistent with the treaty, because we need rigorous analysis of a number of claims that have been made both by Dr. Codevilla and by me.

You cannot just say that you put a guidance system from one missile on another one and it will fly, et cetera, et cetera. You cannot just imply that everybody who has been working on SDI, whether I agree with the program or not, is so incompetent that they have wasted $17 billion. They have worked hard on a very difficult problem. Words cannot grasp the difficulty of that problem the way you have been hearing. I think that is important.

Yes, the SDI program that we should do is important, I believe, because it is a hedge against some of the concerns that you heard from Dr. Codevilla. I do not believe that the Soviet Union has violated the ABM Treaty to the extent to threaten U.S. security. They have violated it with the Krasnoyarsk radar. That was a very stupid and illegal thing for them to do. They have not finished it. Perhaps that will be negotiated away in the future.

It is unacceptable, Krasnoyarsk. Do not get me wrong. But it is absolutely militarily irrelevant if you look at the wavelengths or the frequencies of the radar, its vulnerability and its technical properties in detail, which I will be glad to go into.

They have not violated the treaty substantially. What they have done with their SA-12s in their program is do what the ABM Treaty allows us to do so that we could have a good R&D program to find out whether technology in some future day will give us a better world than living as mutual hostages. I do not like deterrence. I do not think anybody wants deterrence. But we are living with weapons more than a millions times more destructive per pound than anything before in history. I think it is a correct technical conclusion that as long as the world has many nuclear weapons, we are going to live as neutral hostages. That is a physical fact, not a desire, not a great policy. We have to recognize that and we have to build a policy which does not ignore the laws of physics. I think it is important.

Yes, we should have a good SDI research program, so in case there is a threat of breakout from the Soviet Union, because of some of their ambiguous activities, we can respond. We should have a good SDI research program so that we can say we know what can be done as well as anybody else on this earth. Because one's technical vision has a limit. I cannot see, in my own technical

vision, I would say as a physicist, more than 10 years, or to the end of the century.

So I want to have a good technical program. In effect, I want to have a better one than we have. That is why I want to unburden it with the notion of putting things up just because you can put things up.

Look at the Secretary of Defense's report from 2 years ago. He will tell you that the Soviet Union has spent more than $3 on air defenses for every dollar we have spent on our strategic bomber force. He will also tell you that that air defense dollar has done no good whatsoever. It has just driven us from 400 bombers with maybe 2,000 bombs to, maybe it will be 300 bombers or 250 or 350, it is a matter for the budget to decide. But each one of those bombers now will carry 20 or more penetrating air-launched cruise missiles that that air defense system can do precious little to prevent from arriving on target.

So more, smaller bombs, or I should say nuclear warheads, the Cruise missiles, the Soviet Union is now vulnerable to as a result of taking the attitude well, let us do what we can. You have to remember countermeasures.

This is not just a technical problem. It is a problem of man against man. Yes, we can tell many things with the Queen Match program. Yes, we have seen things with previous tests. But that is because no one tried to hide it. There was no incentive to hide a warhead from a decoy or to make good decoys or to make good balloons. You do not have to spin stabilize warheads until they get to the atmosphere. I am talking about midcourse discrimination.

So there are lots of things, there are lots of things that you can get away with. There are lots of things you can get away with if you do not make the effort, if the opponent does not make the effort to stop you. So I do not think that is relevant.

I think to provide options for a limited defense perhaps against other countries, perhaps in an arms control environment in a world in which we are now, as we are at the moment, with such heavy arms, a limited defense would be of value to us. I would like to know what I can do with a limited defense. That is why I want the R&D program to look into that.

I thought Sam Nunn's, Senator Nunn's speech when he raised that issue of the ALPS system a year ago was right on the money—what technologies; we should learn from a research program; and, also learn what we are wasting our money on.

I know a chemical laser sitting in space can shoot down something coming up. But I also know that very inexpensive anti-satellite threats to those circulating chemical lasers are much cheaper. It costs you much less energy and dollars to reach a nuclear warhead up to an altitude to destroy something with its large region of destruction than it costs you to put a precious instrument into orbit circulating at that same altitude; and you would need many of them.

This has been looked at, and I find this interesting. It is my criticism of the SDI program when, before the President's speech, Gen. Danny Graham was saying give us spaced-based interceptors; that is the high frontier. Then the next statement was give us chemical rockets in space. Then people looked at the vulnerability and the

cost of those chemical lasers. Then the criteria associated with the name of Paul Nitze, namely, cost effectiveness at the margin and survivability, were provided. They said do not put things up there that are going to be attractive targets. Do not put things up there that are going to cost you more to put up than it will cost your opponent to increase his threat to neutralize. You will go broke. The chemical lasers did not meet that criteria.

So then the next fashion was come to ground. We said let us do directed energy weapons pumped by nuclear explosives. We were told that would work, too. Now, we are not being told that any more. We realize there is still basic physics to be learned, and we have gone back to the high frontier concept, with the Brilliant Pebbles all of a sudden. It is like the "Moon of the Month" club.

I think it is outrageous that we have spent $17 billion on a program that has not answered some of the basic questions.

I think Dr. Codevilla and I agree on some things here. Namely, there are some real questions to be answered.

I think we have a different judgment on several things.

Has the Soviet Union created a threat by their ABM activities? It is my judgment, no. I think that the best way to answer that is not in an open hearing. You have to get the intelligence information, obviously and make your own judgment. I have been through it, and I have made my judgment.

But I do not believe the Soviets have created a threat. I think that we should, for the reasons I have said, have a good SDI program.

I think that SDI program, the one that is going to answer the very difficult questions which were raised by that American Physical Society study, whose participants were ten, these were in fact more than ten, there were 15 I think roughly, of the finest physicists in this country, from the weapons labs, from the military service one representative, a Nobel Prize winner headed it up, and it was reviewed by senior advisors to the Government, too. They had access to classified information.

They said, and I agree with their judgment, that it will be a decade of R&D before a successful R&D program would put us in the position to know whether some of these technologies would be valuable or not against the kinds of countermeasures that are there.

So I think these are very difficult issues. They involve judgment, as Dr. Codevilla said, because it is not just technology, it is what the other guy can do. They deserve very serious, rigorous study, which I hope this committee is seeing.

In fact, one of my recommendations in my testimony, which I did not state, is that we have need of what is usually called a Red Team, one that is independent of the SDI program. One that is adequately funded, that works with contractors, that works with the intelligence services and really goes in depth into an analysis of what the countermeasures can be. We have not had that.

So I think that we should have a better SDI program. In my mind—and this is I think sort of our fundamental disagreement; we have a lot of principles of agreement I think—in my mind, the program would be a better program if we were humble about how far we have to go, if we would recognize how far the technology

still has to go, that it is not just a technology. I am not a nay-sayer on technology. I had no doubt we could put a man on the Moon. I loved that.

But you know, the Moon did not mind being landed on. The Moon did not put out its lights or run away or anything. That was a technical program. I am a technical optimist.

Here, it is a matter of measures, and countermeasures. Man against man. Very sophisticated and difficult judgments. Here we have the largest R&D program in the United States and we have to see that it is consistent with our goals. I think the ABM Treaty is very important because it is my judgment it has not been violated, and what is more, the Soviet Union, with the hot production lines, could break out of it with their SA-12s, with their Moscow system upgrade. I consider that consistent with the treaty. I want us to do more there. That is why I emphasize a functional prototype of the only ABM system I know we can make.

Ground based interceptors designed for carrying nuclear warheads in an allowed test range as Kwajalein are allowed by the treaty and are important for studying penetration aides. Because if we had this terrible threat to our deterrent that you have been hearing about, why has the Air Force, why has the Department of Defense, why has our Government for the last decade or more, ignored any serious work in penetration aids to overpower it, to saturate it?

Obviously, other people do not agree that there is that great a threat. But in the future it may be there. That is why I think as part of a balanced research program, we should be doing that kind of work, and we need a functional prototype to do it.

As far as mid-course discrimination, just one final comment. Indeed, if someone does not try to make it impossible for you to see something, mid-course discrimination is no problem. But the question of confusion, the question of anti-simulation or simulation, I have to repeat, because again we can go into extensive technical details.

It is a consensus of the community that I as a physicist work with in these matters that we do not know how to do mid-course discrimination if someone wants to deny us the discriminating signal and that it is not all that difficult to do. It has not been done because there has been no premium on doing it.

Mr. DELLUMS. Dr. Codevilla, in the spirit of equal time, I would like to let you respond, and then we will go to our colleagues, because I think this has been very useful. I appreciate it.

Dr. CODEVILLA. Thank you. Why has the DOD not proposed doing some of the things that Dr. Drell talked about?

For the same reason according to this committee that the Navy was blind to certain developments in the quietness of Soviet submarines. It is the same reason why the French Army in the 1930s was blind to the developments in the Wehrmacht.

The reason is that armed forces are conservative in the worst sense of that term. They want tomorrow to be just like today. They are very, very sluggish folks.

RED TEAMS

Why have we not had Red Teams? In the SDI program we have had little other than Red Teams. The SDI program is one great, big Red Team, which lives by the maxim quote: "The responsive threat is a reiterative process." That is to say, we are going to imagine new threats again and again and again. Sandia Labs does very little but Red Team activity. The APS, the American Physics Society report said that we ought to take a good decade before we are ready to decide on ballistic missile defense.

Dr. DRELL. Directed——

Dr. CODEVILLA. Directed energy weapons.

Dr. DRELL. Directed energy technology.

Dr. CODEVILLA. Technology. I can assure you, that any number of people could put together a group of physicists just as eminent, who would come up with exactly the opposite conclusion. It is no accident, as some folks say, that all of the members of that particular panel were anti-ballistic missile defense. They were against the notion that the United States ought to have ballistic missile defense.

It makes a difference what political preferences scientists have. They have those preferences just like anybody else.

Recall the different motivations during World War II of Werner Heisenberg on the German side and of American scientists—many of whom were Jewish refugees from Nazi Germany. Werner Heisenberg, a decent man, was not particularly eager to give Hitler the bomb. Our scientists were, for very good reasons, very eager to get us ours, at least so long as Hitler was in the war.

The Nitze criteria, with regard to chemical lasers. This is, a matter of definitions. There are ways in which the engagements can be defined so that one side comes out ahead, and there are ways in which the engagements can be defined in which the other side comes out ahead.

I was very surprised to hear Dr. Drell talk about, say that you do not need to spin stabilize warheads until they reach the atmosphere.

Warheads are stabilized as they come out of the post-boost vehicle. I do not know of any other way to do it, other than of course putting little rockets on the warheads themselves, in effect making individual post-boost vehicles which has its own problems. It would amount to making a whole bunch of single warhead missiles.

Has air defense done the Soviet Union no good? Ask any pilot who might possibly be asked to penetrate it. The fact that the United States is now——

Mr. DELLUMS. There was a young kid that penetrated it with a very small plane.

Dr. CODEVILLA. Well, one poor fellow——

Mr. DELLUMS. What did you say? Was that a throwaway line?

Dr. CODEVILLA. It was a throwaway line.

Mr. DELLUMS. OK.

Dr. CODEVILLA. You know it.

The fact that the United States is now considering a $1/2 billion Stealth per copy bomber is eminent praise of the Soviet Union's air defense system. The fact that we have stopped production of our

first generation cruise missiles until we can get a more stealthy cruise missile, if we can get it, is eloquent praise of the Soviet air defense system.

I would not want to fly an airplane into that system and I would advise my children not to fly an airplane into it.

Indeed, every time that the subject of building new bombers came up, I recall Senator Gary Hart getting up on the floor of the Senate and making a very persuasive argument that we should not buy them because they could not penetrate.

As for human destruction, the 20th Century has seen many, many human slaughters. All of them have been carried out with weapons far below the state of the art. The number one weapon for human slaughter in the 20th Century, in fact even before, has been starvation, barbed wire, overwork, hand-held weapons, and in the case of Cambodia, wooden clubs.

No. The laws of physics, the fact that we can kill more efficiently, does not necessarily mean that we will do that. Because those weapons are in a way too precious to be used for human slaughter.

In fact, over the past 15 years nuclear weapons have become more dangerous to peace rather than less dangerous, not because they have become bigger, but precisely because they have become smaller, much better guided and more effective against military targets than ever before.

Now, as regards the Krasndoarsk radar. It is indeed irrelevant, but not because its frequency is somehow preventing it from doing ballistic missile defense. That is an argument that I do not believe will hold water.

It is militarily irrelevant by itself because it is only one of nine radars of its kind, every one of which is capable of doing the same thing that it is capable of doing.

Finally, after all is said and done, I am delighted to hear Dr. Drell praise SDI. That will be reported at the Stanford Faculty Club.

Dr. DRELL. Why should I worry?

Dr. CODEVILLA. But I wonder, if SDI has been so good, if it has not wasted its money, then where is the beef? Where is the product?

Mr. DELLUMS. I thank the gentleman. The Chair would yield to the gentleman from Florida, Mr. Bennett, for such time as he may consume.

Mr. BENNETT. Thank you very much. This has been a stimulating conversation.

Most of us here in Congress are people who have not had the educational background that you have. If there were a handful of Members of Congress who would be elected that had similar concepts, because they were so well educated and so bright—the rest of us would kind of have to worry about whether or not they could lead us down any path that doesn't seem to be in our simplistic view, and not necessarily in the interest of humankind.

A simple person like myself listened to what Weinberger told Reagan when there was a threat from the Russians. What he did not call an SDI, he called a lot of production of protection of the whole area, and Weinberger said—and I am not quoting him di-

rectly because I am saying this off the top of my head, that we would just produce more ICBMs and have more countermeasures.

That is exactly what the Russians said when we came forth with the SDI. That is a fact.

I am going to list a few facts first so you can see how a simple person like myself has to approach this problem.

Another rather simple fact, but it is very valuable I think, is the Chairman has alluded to the fact that there are a lot of other things around besides taking care of SDI that require expenditure and Congress has to look at those.

He was talking mostly I think, because he is a very humane Chairman and person, about the humane things of people dying or having health problems or living in ghettos and things like that.

But I am a little more unmyopically military. So I would say I look at it a little differently. I do not think it is the function of the Federal Government to do all of those humane things. Under our Constitution, much of this is left to the local states, although I vote for programs like that. I think the Federal Government must see that the country survives. Therefore, I have a problem about whether or not we are adequately thinking out the places where we ought to put the money in defense.

You have suggested to us, whether purposely or not, that somehow or another Congress is holding back and not being generous enough with regard to SDI.

Dr. CODEVILLA. No, sir.

Mr. BENNETT. Well, let me put it this way. You did say we spent $17 billion. I somewhat question that, because of course you started that with the announcement of SDI. But we spent billions and billions before SDI was ever announced by Reagan, long before Reagan became President.

Dr. CODEVILLA. I know.

Mr. BENNETT. So he did not invent SDI, he just gave a good term for it, which we all now remember.

Dr. CODEVILLA. Oh, yes.

Mr. BENNETT. So what I am worried about there is you did say we spent a lot of money and somehow or another we had messed it up.

Maybe the reason we messed it up is because most Members of Congress are not specialists in this sort of thing. We can see the simplistic thing, and I certainly follow what Dr. Drell said about it, this idea of talking about Carthage, well, you are talking about my father's observation about Carthage, not about mine, or not about my children's. Because today, the Carthage we face is worldwide. It is earthwide.

I am convinced that we could set enough stuff off where everybody would die. That is a little bit different than wiping out 100 million or 200 million people or even a billion people.

If you wipe out all living things, it seems to me you have done something very different from anything that has happened so far.

So now, we have looked at some facts and another fact we should look at, Reagan announced, and I think it is true: that nobody can win a nuclear war.

When you put all that together, what do you come up with? You come up, as I see it, with just exactly what Dr. Drell said. You

come up with the necessity to study this and be adequately funded for it. Give a good figure on it and then do the very best you can to study it. But to march forward to something that may end all humankind on this earth is, I think, a very dangerous thing to do. I do not think it ought to be encouraged. It is what worries me.

You see, I feel like we can spend all these billions of dollars, or trillions, whatever it may be, and lose the war. First of all, I asked General Rodgers. He made an announcement about having 9 days of ammunition in Europe. He was eventually replaced and somebody else was put in his place. But the person that took his place did not deny that.

Since I was in doubt about that, I asked the GAO. I said is it true we only have 9 days of ammunition in Europe? They said, well, it is somewhat true. The real truth is it is somewhere between 3 and 5 days ammunition.

Well, it seems to me then that we are running a great damage and danger to humankind in not being adequately defended in the kind of weapons that are likely to be used.

I am reminded in New Guinea, I had an M-1 rifle. I never used it. Why? Because I had a carbine which would kill much more effectively. You did not take up shots at people hundreds of yards away, which an M-1 is capable of doing. You were within feet of people or certainly within a few yards of people when you killed them. It was just as efficient to do it with a carbine, much more efficient as a matter of fact.

So there it seems to me that the wars that are likely to be fought are likely to be fought, as you say, sometimes with very primitive weapons, very primitive weapons, compared to the things we are capable of building.

That being so, it seems to me we should put our dollars where they are likely to have something to do with whether or not the war is going to be won on the other side or not.

Now, so far I have been making a speech. But I am trying to say to you that I do not see how normal individuals like myself, a lawyer essentially when I came here, how I could be expected to know all these complicated things you refer to. I do not think Congress can do this. I do not think we should micromanage the SDI program. I think we should have a great deal of flexibility in what they do and we should only stop the things that are obviously bad, because somebody is running with it, and he has to be protected within the system. It is the same in the Pentagon as SDI.

Anyway, there are people that protect things, and you have to tell them no, you are not making a success. So there would be some of that.

But I really would lean toward coming up with a figure which could put all this animosity and this explosion to death and come forth with a figure that is necessary for the research to let us get on with it. So you will not be able to sit up here as you did today and say well, it has been an awful mess. You have not used those exact words. But you have implied that Congress was throwing the money away.

Well, it certainly is not because Congress wanted to throw the money away, because Mr. Dellums would like to take care of a lot of people that are in the ghettos or on drugs and I would like to

take care of them as well plus, of course, the fact I would like to be able to win wars. I do not think it is winning wars to spend all this money on esoteric things which are not likely to ever be used against the enemy.

So I think that my feelings are tied into what we can afford to do. I think it ought to be generous, but I think it ought to be agreed on, we ought to go forward with it and we ought to have no more micromanagement than we can help have in the program.

But now getting to the one question I do want to ask you.

Dr. CODEVILLA. Yes, sir.

Mr. BENNETT. What is it that you do dislike about what has happened? In other words, you said that there was all this mess that we have had in the SDI program, and all this waste of $17 billion. Where did we waste it? Whose fault was it? Was it somebody in the Pentagon or was it Congress' fault, this waste of money?

Dr. CODEVILLA. No, it was the fault of those who conceived the program in detail. Their fault was one of lack of common sense, one that your father or your neighbor or for that matter, the average American, can very easily understand, easily as any scientist, perhaps even more easily.

That is, when you spend money without a specific goal, when you go and order from an architect, from a builder, something other than concrete things, you give that person license to indulge whatever fantasies he might have, and not to turn out a product.

There is a certain healthy discipline involved in turning out a product.

Mr. BENNETT. Do you think people should come with line items to us about chemicals and these various other methods and——

Dr. CODEVILLA. No, that is not——

Mr. BENNETT. Have Congress tell you you cannot build a chemical one——

Dr. CODEVILLA. No.

Mr. BENNETT. Or cannot build a laser?

Dr. CODEVILLA. No.

Mr. BENNETT. How much guidance do you want from us?

Dr. CODEVILLA. From the Congress? A fair question. If I were in your position, I would say: Here are $3 billion, $3.5 billion, whatever. You choose the figure.

Mr. BENNETT. I think three is a pretty good figure. I think it is generous.

Dr. CODEVILLA. I will not dispute that. You could even give a lower one.

I would say take this money, and come up with some anti-missile devices by such and such a date. You fix the price and the date. That will provide needed discipline.

If you do not do that——

Mr. BENNETT. What would you like to shoot down? We have an Aegis now that does shoot down some of these things. Now if you were writing it, what would you tell them to shoot down?

Dr. CODEVILLA. For $3 billion a year over the next 3 years, you could get a fleet of 500 Aegis units roaming the country and defending ballistic missiles.

Mr. BENNETT. That would be contrary to the ABM Treaty, would it not?

Dr. CODEVILLA. It would be no more contrary to the ABM Treaty than what the Soviet Union is doing with regard to the SA–12. It is precisely the same thing.

Mr. BENNETT. You think the ABM Treaty is already dead?

Dr. CODEVILLA. Yes, sir. It is alive for those who wish it to be alive and it is quite dead for those who wish it to be dead.

Mr. BENNETT. Do you think this is a happy adventure for humankind if it is dead?

Dr. CODEVILLA. Well, I do not know. But the fact is that dead is dead. I do not think personally it would have been nice for the world to live forever under the incubus of destruction. But the fact is that it does no good to pretend that this treaty is alive, when in fact it is dead.

Mr. BENNETT. Let me ask you this question. Do you have the slightest idea that any SDI that mankind is likely to invent is going to stop more than say 90 percent of those things coming in?

Now, I have talked a lot. How about answering that yes or no?

Dr. CODEVILLA. Sir, 90 percent of what?

Mr. BENNETT. Ninety percent of those missiles or other weapons coming in. In other words, 1,000 rounds comes in, or 10,000. They have 10,000 rounds now. Would more than 9,000 of them be stopped?

Dr. CODEVILLA. Would you shoot, if you had 10,000 rounds would you shoot them all?

Mr. BENNETT. Well, I am not asking that. You are leading me down a path that I am not capable of going down.

They have 10,000 rounds. Do you conceive of any system that will stop more than 9,000 of those rounds?

Dr. CODEVILLA. Yes.

Mr. BENNETT. Really?

Dr. CODEVILLA. Sure.

Mr. BENNETT. Well, you are almost alone then. I never heard anybody else say that.

Dr. CODEVILLA. My point is that a lot depends, on how those rounds are fired, when, under what conditions, what the physical hardness of the rounds is. "It" may stop whatever the attack is. But we have not defined "it." We have not defined the attack.

"It" may stop all of them with a lot of capacity to spare, or it may stop only a tiny percentage. I do not know. Everything depends on the details.

I am not trying to evade your question.

Mr. BENNETT. You may not be trying, but you are succeeding. Well, I do not mean you mean to be deceptive in any way.

Dr. CODEVILLA. No, sir.

Mr. BENNETT. You see, I guess that is one of the problems. You are a very, very well educated man. I am a fairly well educated man. But I am a rather simple man. I do not really understand when you cannot answer when I say if 10,000 rounds are coming in how do you think that you are going to stop more than 9,000.

Dr. CODEVILLA. All right. The answer is yes, providing you have enough things. I mean, literally, sir, you could fill up the sky with defenses.

Mr. BENNETT. Well, do you think any of them will get through? Do you think the chances are at least 1 percent will get through?

Dr. CODEVILLA. The chances are always that there will be some failures.

Mr. BENNETT. All right.

Dr. CODEVILLA. Of course. Of course.

Mr. BENNETT. Now that being so, let me share with you something I have bored people with before, but it is out of my life.

Dr. CODEVILLA. Sure.

Mr. BENNETT. That is in World War II I fought in the Philippines, and I get to a Nipa hut, and I have my carbine with me and I can wipe out everybody in that Nipa hut with one chamber of my carbine. If I approach a Japanese man who has dug into the wall, into the stone, as many of them were, I would have to take at least a squad, maybe a platoon, maybe a company, and I would have to rain down on him all kinds of weaponry.

Dr. CODEVILLA. Yes.

Mr. BENNETT. Otherwise, I would never be sure I would get him.

Dr. CODEVILLA. Yes.

Mr. BENNETT. Well, that is the same thing that is going to happen to us. If we perfect something that would allow some to come through, then the obvious answer, as both Weinberger said, and Gorbachev said, both of them said it, the obvious answer is to produce more ICBMs. That is the obvious answer. Why not?

If you have 10,000 rounds, that is 1,000 rounds for America to get at us, wipe out my home town, which is the 17th largest city in the United States, we can wipe out everything larger, and we would still have 980-some odd rounds left to go.

That is a pretty ominous situation. I do not see why you would want to pursue it. Why would you want to pursue it when we do not have but 3 days of ammunition in Europe to win a conventional war? What sense does that make?

Dr. CODEVILLA. We need more than 3 days ammunition in Europe. But the fundamental argument is not simple, that you have made. It is incorrect.

In World War I, when men were being sent against trenches to be mowed down, they were not all mowed down. Some got through. Was the answer, was the correct answer to send more——

Mr. BENNETT. Grant answered that. Grant answered that. That is why he beat the South. He did not give a damn. He just put more and more people in. As long as things were evenly matched, Lee beat him. But when they got Grant, he was willing to put them all up there and get them all shot down, and that is why he won.

Dr. CODEVILLA. That, by the way, was the answer that Von Falkenheim gave on the Western Front. He tried the Grant strategy. It did not work. He lost.

Mr. BENNETT. I guess you could find a historic example for everything. But the one about Grant is more realistic to me in my background.

Mr. DORNAN. Would the gentleman yield?

Mr. BENNETT. I have really about exhausted myself. But I will yield, so I can go back.

Mr. DORNAN. I will be glad to yield at the time after Mr. Dellums gets around to me.

I think the fair way to ask the question is if you could destroy 90 percent of the temptation of an adversary to move—I just did a

little arithmetic here. The Japanese sent 353 planes against Pearl Harbor. They lost 26. So that is a little over 7 percent. They were prepared to lose 25 percent. But if they thought they were going to lose 50, maybe 40, maybe even 30, they might not have struck, because that was all the planes they had in that part of the Pacific. It was a max effort, and held back two carriers at the mainland.

I just think that the problem is to deter war and to confuse the whole war planning of the people in the Kremlin, and that is the appeal of SDI to me. But I just think that is the fair way to ask, is it 90 percent of temptation or 70 percent? They say let us wait a few years until we get a little stronger and the U.S. gets a little weaker.

Mr. BENNETT. Well, you are redefining my position. I believe with Dr. Drell we ought to spend whatever is necessary in doing the research. I think we should ask all the necessary questions. Our big problem is how to get rid of the things we should not be asking and I am not bright enough to know and I would not want to put that up to a vote in Congress because I do not think the average Congressman knows. I think scientists have to tell us which things are productive things to pursue, and we could make a law that left out some things.

But it is not a question of whether you want your country to be protected, because we both want our country to be protected. I just think my country is going to be more protected by an infantry soldier than it is by an atom bomb. That is all I have to say.

Mr. DELLUMS. The gentleman yields back his time. The Gentleman from Arizona, Mr. Kyl, is recognized for such time as he may consume.

Mr. KYL. Thank you, Mr. Chairman. First, I want to compliment you on conducting the discussion or debate here. You are no Morton Downey, but you do pretty good.

[Laughter.]

Mr. KYL. I am sure our witnesses have figured out by now, beware when Charlie Bennett proceeds a question saying you know, I do not know all that much. I am just a simple man.

[Laughter.]

Mr. Codevilla, let me start by asking you a question. It bears on the question Mr. Bennett just asked.

What is the purpose for an SDI system? What does happen if 10 percent or even 20 percent of the missiles could get through? Is my colleague, Mr. Dornan, correct that the whole idea here is to deter aggression rather than fighting the war?

Dr. CODEVILLA. Of course, the purpose is to deter aggression. You deter aggression by making its fruits less certain and more expensive.

This image of the Soviet Union as bent at whatever cost to attack the United States is far from reality.

It is interesting that this image is being put out by some who otherwise say very nice things about the Soviet Union. In fact, the Soviet Union has only a finite desire to attack the United States. It may not have any desire at all, at this point. It may simply be tempted at some time in the future to do so.

We know from our own experiences as human beings that when the temptation is there, and when it is cheap and easy to satisfy the temptation, we tend to give in to it.

But when the temptation is more expensive to satisfy, when the fruits of the temptation are more difficult to reap, we often do not give in to the temptation.

That is why there are locks on doors. Not because it is impossible to break through the locks, but to deter most people from trying to go through.

The principal purpose of a strategic defense system is to take away the temptation that counterforce missiles are giving.

The second purpose is a kind of insurance, should, for some reason, the disaster occur, to minimize its effects.

Mr. DELLUMS. Let me ask you a question. Would the gentleman yield briefly?

Mr. KYL. Sure.

Mr. DELLUMS. Just so I could understand how you move in your argument. When this Nation advocated the development of counterforce weapons, did you support that advocacy? Did you support MIRVing and capability that gave us a counterforce mechanism?

Dr. CODEVILLA. I did.

Mr. DELLUMS. The interesting thing about the logic of that argument, is that it is the logic of the Pentagon's argument: which is give me this weapon. Then you step one generation back and you point out the danger of that and you want to pursue another technology. Then you support that and come back with the next generation saying look at the evils of that technology, and it keeps going forward. Because if you advocated counterforce weapons now, you say we have to do this because of the dangerous counterforce weapons, when many of us were saying on the front end we did not need to go down that road because arms control was a more efficacious direction.

Dr. CODEVILLA. Mr. Dellums.

Mr. DELLUMS. I will get to you, sir.

Dr. CODEVILLA. Mr. Dellums.

Mr. DELLUMS. Dr. Drell will come after you. But please respond.

Dr. CODEVILLA. You have made a very good point, except for one thing.

Mr. DELLUMS. OK.

Dr. CODEVILLA. The United States, in the 1960s, went out of its way not to develop counterforce weapons. I advocated that we should have these things because I believe that the Soviet Union was doing its darnedest to get them, and because, should we ever shoot, it would be more humane and more effective for us to shoot at weapons than at people.

But you must recognize that there is a substantial difference between ourselves and the Soviet Union, in our intentions and in our respect for human life.

I think that the American people would agree with me that the world was far safer when the United States had nuclear superiority than it is now when the Soviet Union has it. There is a difference between ourselves and the Soviet Union. It is not the same for us to have it as it is for them to have it.

Dr. DRELL. May I please comment on the point, and the question raised by Mr. Kyl? Because I see it a little differently.

I agree with the point that one wants to make the fruits less certain and more expensive. That is a broad question we have to look at for our entire strategic forces. Then we have to come to a decision based upon the resources available, which do not grow, what is the best way to do it?

I think that is a question where the jury is still out, in my mind. Do we do it by mobile ICBMs, one form or another, which is being debated or do we do it by the kind of terminal defense which I said we should do a functional prototype of even with nuclear warheads? I think the jury is still out.

The last time we went over this question I think we made the right decision, that doing it with ABM was not the way to go, because the countermeasures in adding more warheads were there.

You also asked about an accident, one of you asked about an accident. That is why I said one should have as one's goal in this research program to see if an ALPS or an LPS, a limited protective system, makes sense. It is my technical judgment we do not have that concept now. That is the kind of thing I think the program should be doing when I say R&D because I think these are the important and answerable questions as technology advances.

The comment about counterforce and MIRVs. Just look at what happened when the Soviets started to build an ABM system around Moscow in the middle 1960s with some suspicious activities at Tallin.

We were faced with a decision how do we make sure that that ABM system of theirs is not effective and that they do not even themselves think it is effective. We said we have to put decoys, jam it, whatnot. The best way to do that was to make each decoy into a warhead and to make each missile into a hydraheaded monster with many warheads. Indeed by doing that unilateral action, the Soviets, and it is probably one of the dumbest things they ever did in this area anyway, they ended up stimulating us to MIRV. We started and we did not stop when the ABM Treaty, by severely limiting defenses, said we could stop.

You have implied, the world is not more stable now as a result of that failed opportunity for restraint once we had the ABM Treaty. So new weapons do lead to the counterweapons and lead to the spiral which has not made this world more safe.

Mr. DELLUMS. Mr. Kyl.

Mr. KYL. Mr. Chairman, that gets me to a very basic question here of what method we should use to deter strategic war.

Now, Mr. Bennett makes the point that maybe the war, or the next war will not be strategic, nor will it be nuclear. It will be conventional. Maybe so. But we do have to defend against both eventualities, and I think we all agree with that.

Mr. BENNETT. We are not doing one. We are not conventionally defending.

Mr. KYL. I would certainly agree that we could do more in that area. I know you were not suggesting that we should not pay any attention to the strategic.

So the question is, how do we best do it? Do we do it by relying on the doctrine of mutual assured destruction? Or do we do it rely-

ing upon defense? Or do we do it on a combination of the two working together? Or is there some fourth option that we have not thought about?

I am leaving out the option of eliminating all possible threat by treaty because I do not think anybody has yet proposed that that could actually work, at least not in the short term, and history does not suggest that we should rely upon it. But I suppose some might consider that ultimately all weapons of any kind could be banned, and that would be a wonderful world.

But for right now, I want to concentrate on the first three options.

Mr. Dellums quoted Lord Mountbatton, generally to the effect if I understand it that nuclear weapons are so horrible really that they can never be used.

Mr. DELLUMS. Yes. One other thing he said was that the only role of nuclear weapons in our lives is to deter their use.

Mr. KYL. That is what makes the first part meaningless, then. If you cannot use a nuclear weapon, then of course it does not have a deterrent effect. That is what I was getting at. To have the doctrine of mutual assured destruction be effective, it has to rely upon the proposition that you have weapons which A, can be used and B, would if necessary, be used.

Mr. DELLUMS. And C, if used, would create such incredible damage that it would destroy yourself and your adversary. It is in that irrationality that you have the concept of deterrence.

Mr. KYL. Yes.

Mr. DELLUMS. But that third point is a very important point, though.

Mr. KYL. Certainly.

Dr. CODEVILLA. It sure is.

Mr. KYL. There are many things that could be said about that. But in any event, my question to both of you gentlemen is this. One more predicate.

Dr. Drell, I get the impression that you favor SDI purely as a research program, not as a deployment project. I am not sure why. So in a moment I am going to ask you about that.

But my preliminary question is, to both of you, in concept, do you favor a defense based upon mutual assured destruction, upon defense, a combination of the two, or some other option?

Dr. DRELL. Do you want me to try first?

Mr. KYL. Sure.

Dr. DRELL. The answer to that question is not an absolute one. I favor doing what we can do best to avoid initiating a nuclear war. Because I think the key is to build a stability that decreases the possibility of war.

Mr. KYL. In your opinion, what is that?

Dr. DRELL. In the past I think we came to the correct conclusion, in the last big debate on this in the 1970s, that deterrence without defense, because the defense looked so unable to meet the Nitze criteria that it would stimulate more offensive buildup, cheaper, easier, more effective.

I favor not just doing research in SDI. I favor at this time doing the research to see if there can be another answer.

To me, the ABM Treaty and deterrence is the only alternative that I recognize exists today on technical grounds. It is not the best of all worlds, no. I want a good research program because if one could come up with a rigorously analyzed and understood case that there is a safer world by abandoning the ABM Treaty at some future time, we would have to then look at it. That is what every treaty says. When it becomes in your national interest, you re-examine it.

I am not willing at this time to abandon deterrence as we have known it in the treaty because it is my technical judgment that we do not have anything better yet to replace it with.

So when I say do research, it is not because I am content. It is because it is my technical judgment, that is all I can give you, that we must still work to see if we can create a better one, either by hardpoint defense of the deterrent force because that turns out to be the best way to do it—that is not true today; whether we want to modify the treaty because some limited protection system makes sense. I do not know that today, but that is one of the research goals that we should have of our research program.

So it is not that I am locked into a concept. To me the goal of our strategic posture is a stability that is going to make the use of these weapons least likely.

Frankly, just to conclude, I think constructive political dialog is going to have much more to do with a safer world than just a treaty or a weapon. Because I think it comes when two countries understand for good reason that we are not the evil to each other, that we have higher interests of surviving in the world; it is the political dialog which was started in the last 3 years and which I think will contribute more to our security than the imperfect technology I know.

Mr. KYL. So you have clarified a great deal in my mind then.

You believe in the best system, which could be defensive, but in the past has been offensive.

Dr. DRELL. Yes.

Mr. KYL. It might be a combination of the two. But your objection to doing anything more than currently researching SDI is that you do not believe that technologically we are anywhere close to any decision to deploy part of the system.

Dr. DRELL. That is right. That is exactly right.

Mr. KYL. All right. With respect to that, I have this question.

You said some very complimentary things on both Page 4 and Page 10 of your statement about SBI, the space-based interceptors.

Dr. DRELL. Yes.

Mr. KYL. Incidentally, you identify significant problems with mid-course discrimination for other weapons.

Dr. DRELL. Yes.

Mr. KYL. It seems to me that, based upon your observations, based upon the fact that you get more efficiency out of an effective SBI system because you kill in the boost phase, you do not have to worry about the mid-course discrimination, and we are perhaps further along there than anywhere else, that the logic then with respect to your position is to aggressively prioritize and pursue a course of action that would permit us to deploy that kind of a defensive system—a lock on the door, rather than Grampaw sitting

in the rocking chair with a shotgun waiting for the guy to come through the door.

Dr. DRELL. Yes.

Mr. KYL. Therefore, I do not understand your prioritization to put the SBI system on the back burner when really what we are ready to do now is to, in fact, test to demonstrate and validate the concepts. Instead you would prioritize the much more difficult problems such as mid-course discrimination and so on.

Dr. DRELL. It is my judgment sir that the present concept of SBI, the one that has been engineered and they want to do the test on, is a sure loser. The interesting ideas that are coming along, which I have always pushed, is seeing that the technology of very small interceptors, that are inexpensive, can be developed.

Now, I know that General Abrahamson in his farewell tour of duty statement gave great play to the brilliant pebble concept. But I am reminded of the fact that if you look at the record of the last 25 years of air to air interceptors, that is a very mature technology. It has been an evolutionary one. We started with very advanced ideas that have gotten very expensive. AMRAAM, our latest one, goes 40 miles, weighs 300 and some pounds, was going to cost $100,000 and do everything. It now (fiscal year 1988) costs $1.7 million a copy and does much less than everything.

All of a sudden we are faced with the possible concept that the Brilliant Pebbles are supposed to be a revolution in that technology.

It seems to me that if you look at the restraints that the budgetary process from Congress has put on the space-based interceptor program in the last few years, you see that the program has matured a fair amount by doing the research I am calling for, and even its own project manager is quoted, Colonel Simmons, as saying that the delay in testing while looking into advanced seekers and propulsion components, has meant that the program—he said previously planned flight experiments would not have demonstrated the advanced technology needed for an operation of SBI. They were a bigger animal, the previous generation in terms of size, weight and performance.

That is a good example from the program manager of exactly why there is a careful choice to be made. At that moment I am not going to micromanage the program. I am not in there every day. When they have to start testing it, they can test consistent with the treaty. So I am not disagreeing. But I am just saying we are not yet there, and I do not think Brilliant Pebbles has achieved that status. It is a theoretical concept only today.

Mr. KYL. Dr. Codevilla, would you like to respond to that?

Dr. CODEVILLA. We can get later generation seekers, we can get later generation everything. We can always judge them inadequate according to some standard that we can make up at the time.

The only standard that really matters is the operational one. You build real things, you actually test them, and then you decide whether in fact you have something that works.

This business of testing things without ever building them by studies, by their adherence to this criterion or that criterion, is intellectually corrupting. It also guarantees that we will continue to

do what we have been doing for the past 8 years. That is to say, stamp our feet, mark time, while paying an awful lot of money.

A sure loser against what? Against what threat? Against something that really exists or against something that exists nowhere except out on some piece of paper?

The fundamental question is how do you deter? By what mix of offense and defense? Look at offense at first. You must bear the responsibility of deciding where you are going shoot. It makes a very great deal of difference what you shoot at.

Do you shoot at their missiles? Do you shoot at their people? If you shoot at their people, which people?

Such decisions make a tremendous amount of difference both in terms of deterrence and in terms of what happens afterwards. If we are going to shoot at all, our ability to destroy their weapons will do us the most good, and will have the greatest deterrent effect.

Ten years ago, President Carter, in perhaps his finest hour, ended mutual assured destruction by reordering the targeting priorities of the United States. Henceforth, said President Carter, if we are going to shoot, we are going to shoot at the things that can harm the United States. We are going to shoot in a way that will minimize the damage to the United States.

More precisely, he said, in Presidential Decision 59, after having absorbed the first strike, we will, shoot at the Soviet Union's reserve missile forces. Thereby, we will deprive the Soviet Union of the ability to coerce us. Hence, went the line of reasoning. The Soviet Union deprived of the ability to coerce us after an attack will not be tempted to attack in the first place.

This made a great deal of sense at the time. However, in the meanwhile, several things have happened.

The Soviet Union's reserve counterforce missile forces, are no longer where they can be shot at. They are being put on rails and on trucks.

Furthermore, active defense is now out there in the Soviet Union and growing.

So although President Carter's PD 59 concept made a great deal of sense, it is not something that the United States can rely on now or in the future.

We can improve, on the offensive side of the equation, not so much by building new weapons but by building new intelligence systems. Our intelligence, our technical intelligence systems right now are meant to give us very fine looks at rather few things that are carefully chosen, much in advance.

It is within our power to build intelligence systems that will give us not so good looks, but intelligence of lower resolution, that is multi-spectral, and that covers much broader areas. Indeed, it may be possible to achieve a kind of staring capacity, though certainly not from geosynchronous.

So much for the offensive side of deterrence.

But no matter how much we do on the offensive side, we are still not going to be able to take away that temptation unless we can show the Soviets that if they launched an attack, a large but unpredictable proportion of that attack would never reach its intend-

ed destination, because we could destroy their missiles on their way. We could protect ourselves.

Many of the means for doing that are at hand. Just how well these means would work, no one knows. That of course if part of deterrence. It would not be the first time in the history of the world that weapons have worked better than they were supposed to. Lots of times they have worked worse than they were supposed to. It would not be the first time they have worked better. That would be a powerful deterrent effect.

Some have said that it would be a good idea, perhaps Dr. Drell would agree, if we had paper mache lasers in space, so long as the other side was not sure of their effect.

Recall that when the United States had an air defense system, the Soviet Union stopped the production of its strategic bombers.

Mr. DORNAN. Say that again?

Dr. CODEVILLA. At the height of the United States air defense system, in the late 1950s and early 1960s, the Soviet Union stopped the production of its strategic bombers.

They did not do what some say, simply produce more bombers to overwhelm our defense. Instead they stopped. They only began to build bombers again after the United States has substantially dismantled its air defense system. That makes sense. Why should someone build something which is going to be mostly, largely or substantially defended against? Much better to channel one's efforts into unexpected, new, different, more effective fields.

People do not spend their money to get diminishing returns. Not in the real world, anyway.

Mr. KYL. Mr. Chairman, I could ask many more questions. But in view of the time and the fact that others have not spoken, I would like to yield back the remainder of my time.

I would like to make this observation though that this hearing has been, I hope useful. It has been very, very interesting to me personally, because we have not adhered to a 5-minute rule. You have tried to let everybody get their views back and forth. I think that is a good thing. Maybe we could have been slightly more constrained in the use of the time. But I think that with slight modifications this format can be very useful for this kind of a debate in any event. I compliment you on that.

Mr. DELLUMS. I thank the gentleman. We are exploring, as I said. This is my first effort at chairing the Research and Development Subcommittee. We are trying to find various ways to bring these matters creatively before the body so that it energizes our thought processes. I thought that this would be an interesting colloquy, and particularly when we can move away from the Pentagon and bring other people with dispassionate views who have different axes to grind than the Pentagon, that does give us the luxury of being able to sit back. I appreciate my colleague complimenting me. We will try to fine tune the process.

Mr. Pickett is now recognized for such time as he may consume.

Mr. PICKETT. Mr. Chairman, thank you very much. I had to leave. I take it while I was away Mr. Bennett made reference to conventional forces. Just as a passing comment, I have never been able to rationalize the interrelationship that the war planners have between the strategic and the conventional. Because the traditional

notion of war is that you take and hold territory and you do not do that with strategic weapons.

But the point that occurs to me, Dr. Codevilla, was the one that you made just a moment ago. That is that you do not arm against a defense that is going to be successful against your armaments.

So let us assume that the SDI is successful. Then, the other side is going to go to some other type of offense. What is that?

Dr. CODEVILLA. Lord knows. The Good Book says: "Sufficient unto the day is the trouble thereof."

If, in our lifetimes, we can take care of the ballistic missile problem, we will have done good work, we will have justified the food we have eaten. But just as those who in 1918 struggled mightily to find an answer to the machine gun and the trench, I have not thought about that. I really have not. I do not know. I guess new versions of political warfare, perhaps; new versions of small, evasive Cruise missiles launched from coasts stealthily.

But in a way, I do not see anything that is quite so dangerous as the ballistic missile, because the ballistic missile does something that military commanders have wanted to do since the dawn of time.

Since the dawn of time, military commanders have wanted to take out all or most of the other side's key installations, key things, key forces, at one stroke, at the beginning of the war. Now, for this brief period in history, that dream, that rather nasty dream, seems to be within reach.

If we can get rid of that offensive vision, perhaps it will be a long time before technology and will combine to produce a situation, as dangerous and, as hair triggerish as we have today.

Mr. PICKETT. Dr. Drell, do you want to comment on that?

Dr. DRELL. I think that the question was what would be the other threat.

I think first of all, cruise missiles which are a growing force, will inevitably become a growing threat. The United States has already moved a finite part of our deterrent to Cruise missiles. The air-launched and the sea-launched, nuclear armed tomahawks are coming along also.

I think that if one could remove the threat of ballistic missiles, that would be an achievement. The problem is that I do not see that we can do that yet. I have to come back to what I see are the technical realities. It may not work if it is a defense that cannot do mid-course discrimination, a defense that can only rely on boost phase with small interceptors but against which the offense can have faster burn boosters, and a defense which we have not thought through the meaning of with boost phase intercept, with small interceptors, when you realize that that works because you are committing it within 20 seconds of your information, or 30 seconds of the information, in a computer run system, an automated system. The systems questions are much more complex and difficult than just "do I have a kill mechanism?"

So my point is that sure, it would be great to get rid of a ballistic missile threat, to buy more time, if one could that way. But I just submit that we do not know how to do it and that is why my view is, continue working to see if we can and, if we can, then there will

be a reason to sit down and negotiate a better regime than the one we have under the ABM Treaty right now.

Dr. CODEVILLA. May I say, sir, that fast burn boosters do not exist.

Dr. DRELL. That is because there is no reason for them to exist.

Dr. CODEVILLA. But they do not.

Dr. DRELL. There is no technical problem, and that has been said by the contractors who build them. It is not that it is impossible for them to exist. The question is, is it easier to decrease the burn time from 5 minutes to 3 minutes, or the deployment time from the bus in half, or for you to make an entire defensive system. Let us have the rigorous analysis on that. So far it has not come out in favor of defense.

Dr. CODEVILLA. If I may say so, the rigorous analysis on that subject says that although it is possible to make essentially an intercontinental cannon, which is what these fast burn boosters are said to be, this intercontinental cannon would not have the kind of accuracy that is required, because a missile gains its accuracy outside of the atmosphere. It does not gain its accuracy within it.

So, if you had these fast burn boosters, they would not be nearly so dangerous as today's missiles are, because they could not be used in the kind of surgical strikes that we fear.

In order for them to do that, they would have to get the—warheads outside the atmosphere's, unstable environment. The air hampers it. The guidance system cannot get fully stabilized until it is outside. Once the warheads were outside the atmosphere they would need other guidance systems, in effect new missiles, springing out and doing the things that post boost vehicles now do. In other words the Soviets would have to more than duplicate their present fleet.

Unless we dithered, it would be easier for us to build a fleet of space-based lasers and Aegis radars on the ground than it would for the Soviet Union to duplicate a ballistic missile force which it has impoverished itself in order to build.

Dr. DRELL. Might I just comment, that this is a question which again needs more numerical discussion than flat allegations.

If you say a nuclear cannon, or indeed you try and have the burn finish within the atmosphere, that is true.

But the question is numerical. If it now takes 5 minutes to boost and another 10 minutes or whatever it takes to deploy the warheads, what happens to your system if it would take 2 minutes to boost? You are well above the atmosphere then. Not 60 second, but 2 minutes. Maybe only 2 minutes to deploy the warheads. That kind of tradeoff is much more difficult to judge. So far, you will just have to accept the technical judgment and look at the contractor reports that were done for SDI, and the challenge to make fast burn—not fastest burn, but faster burn—boosters, much faster burn, is not a difficult one, I submit.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. DELLUMS. I thank the gentleman.

Dr. Codevilla, let me first say to you that from my perspective, deterrence is not a military concept; it is a political statement, number one.

Number two, I find it very interesting. Because you mentioned in your opening remarks that you are not a politician. Well, that comes across very clearly. I say that not for any negative reason whatsoever. Because in your notion of exchange and war fighting discussion, I am a politician. Perception is the cornerstone of politics.

I believe the reason why I am willing to challenge you on the notion of surgical strikes and limited nuclear war is because those are concepts totally devoid of political input, because I believe that neither side would conclude a nuclear exchange as long as they believe that the perception of that exchange was that they were on the other end of it.

If you think Mr. Bush would end a nuclear exchange, where Mr. Bush would have to go on television, with the world perception that we were in an inferior position to the Soviet Union, I think you are living in a never-never land.

Let us turn it around the other way, with respect to the Soviet Union. They would not, in my humble opinion, do the same thing.

So when we start talking about deterrence as a military concept, deterrence is a perception. It is politics. I do not believe in the notion of surgical strikes or limited nuclear war. I believe that on clear political terms, with perception being the driving factor, that once the genie is out of the bottle, the genie is out of the bottle. These sophisticated calculations—I remember I sat in this room in the 1970s when I first was on R&D, and the guy was sitting at that table and went through sophisticated notions about this strike and that response and this response and that response, and they were counting missiles.

They said, based on our computer run, we win.

So I asked a very simple question: How do you define victory? He said whatever society is capable of rebuilding its economic infrastructure first is the winner, irrespective of the notion of millions of deaths.

You used the term 25 and 50 with respect to Mr. MacNamara's definition of deterrence. I thought it was more like 70/30.

But even if you use 25, if you transpose that in terms of the population of the United States, you are talking about in excess of 50 million deaths. How can the human mind comprehend 50 million deaths no matter how brilliant? I do not think the human mind can even embrace that level of mega-death.

So when we use these numbers, then when you translate those numbers in real terms, they become awesome.

To destroy 25 percent of your adversary's population, that is just a number, one fourth. But when you translate that in terms of a nation in excess of 200 million people, you are talking about a level of death beyond comprehension.

So I am saying that I do not believe in the notion of limited or surgical strikes, because I think in the real world of politics, that deterrence is not a military idea, it is a political term, and I think perception plays a large part in that and I do not think the United States is ever going to say no missile throws, we are coming in second.

But that is when the macho mentality it seems to me allows us to keep marching forward.

Therein lies, in my humble opinion, the weakness of the assumption upon which your argument is based, which is, in my judgment, devoid of the political ingredient that goes into the whole concept of deterrence, perception.

Dr. CODEVILLA. Well, sir, first, I, with every bone in my body, believe that it is both moral and practical to try to avoid the death of human beings.

Second, regardless of perceptions, sometimes military reality intrudes rather massively on things, and wars do get won and they do get lost. Regardless of what people want or say they want, these results are sometimes dictated by military preparations and very, very cold calculations.

Our hearts should be warmer than those of others. But our calculations should be just as cold as anybody else's.

Mr. DELLUMS. I will just say on the first point that I would agree with you. On the second point, someone much more brilliant than myself, when we developed nuclear weapons, they said everything changed except the way we think. I am simply suggesting that we change the way we think.

Mr. DORNAN. It was Einstein you are quoting.

Mr. DELLUMS. Thank you.

Dr. DRELL. Einstein said something else, by the way. He said politics is much harder than physics. Something else to keep in mind.

[Laughter.]

Mr. DELLUMS. I think that is apropos of this discussion.

Just one last comment, Dr. Codevilla.

Dr. CODEVILLA. Yes, sir.

Mr. DELLUMS. I think this is a classic juxtaposition, and it is fascinating that you two gentleman, at the same institution of higher learning, one is saying let us place a major emphasis upon basic research, let us move, let us assiduously pursue these difficult questions.

You are saying, on the other hand, let the emphasis be on deployment.

Early on, when we began these hearings, we had a few days of luxury, we had no Secretary of Defense, we had no Bush budget, so it at least allowed us to step back and establish a framework for these discussions.

I remember, my colleagues will recall, a number of the scientists who came before us early on really recommended, not with respect to SDI, but the R&D program generally, to go in directly the opposite direction which you advocate, by saying that the extent to which the mandate is deployment is the extent to which you short-circuit the process, you do not allow the scientists and the engineers to have the luxury of pursuing ideas, of failure, of challenge, of exploring new areas, because the politics of the moment is get something out there.

So you end up with a weapons system that is inadequate ill conceived, and inadequately drawn, because the pressure of the effort is toward deployment.

When I came on as Chair of this committee from another subcommittee, I said how much money is spent in deployment as against research? How long do these programs stay as basic research? I started to see something very alarming. That the politics

of this situation leave programs in basic research briefly. The next day you are in full scale development, the next day you are in procurement, and a whole different level of constituencies are out there pushing the weapons system forward. The Congress and the American people are rendered impotent in their capacity to demand an honest debate in the marketplace of ideas, because the system has gone forward.

The B-2, for example, is a simultaneous project. Basic research on the one hand, development on the other. America will own a number of these weapons before they even know if the doggone thing will fly.

Again the politics of pursuing development at the expense of asking questions.

So my question to you is, if the scientific community is saying that if you expand the definition of national security to include our economic wellbeing in the world, that we ought to be spending more of our energy in basic research where our real competition is coming in the world—actually where we are having our socks beaten off of us—rather than who can best build a weapon to go into space. Also, that it is more efficacious for this society to spend more money on basic research even on the military side than it is to pursue the aggressive politics of deployment which means everybody scrambling to put something out there even if it is not thought all the way through and the answers have not come.

Dr. CODEVILLA. On the social side, you are absolutely correct, sir. This country spends far too little on basic research.

On the military side, I do not see how you can say what you have just said. Because the fact is, and this can be seen in any number of the Secretary of Defense's reports and I doubt that there is any data in the other direction, that over the past 20 years, the length of time between the conception of a weapon in the military field and its fielding has roughly tripled in the United States.

Now, this cannot be ascribed to the growing complexity of technology.

Mr. DELLUMS. You responded to a different point that I made. But it is all right.

Dr. CODEVILLA. This cannot be ascribed to the growing complexity of technology because during that very same period of time, that period in the Soviet Union has remained roughly the same.

But in general terms, in terms not related to the military, you are absolutely correct, and I would agree with you 100 percent.

As regards the military, I think the facts argue quite the opposite. We are spending far too much time on basic research.

Mr. DELLUMS. OK. My distinguished colleague from California, Mr. Dornan. The Chair will yield to the gentleman for such time as he may consume.

Thank you, gentlemen, for your response.

Dr. CODEVILLA. Thank you.

Mr. DORNAN. I thank the gentleman.

In 1978, in the second year of my Freshman status, I had the pleasure of traveling with Dr. Codevilla to Geneva. Jack Kemp, who went on to greater glory, was with us.

I wonder if you could give me the year, if not the month and the year, of that Presidential Decision 59 of President Carter?

Dr. CODEVILLA. July.

Mr. DORNAN. July of what year?

Dr. CODEVILLA. 1980.

Mr. DORNAN. Of 1980.

We discussed on that trip, with many things, the fact that there was an inherent immorality in targeting population centers.

Dr. CODEVILLA. That is right.

Mr. DORNAN. That was a Spring trip as I recall, possibly April of 1978.

So we preceded by 2 years and 2 months President Carter's decision, which you said will be to his everlasting glory, to change this.

Dr. CODEVILLA. That is right.

Mr. DORNAN. It was his last year. I remember taking the floor of the House and saying that this was a glorious moment, because I had discussed it with none less than the Supreme Commander of the Allied Forces in Europe, Alexander Haig, then a four star General.

Now, without boring everybody except Charlie Bennett—I always love it when he makes references to his very real combat experiences—let me explain something about one of my observer combat experiences as a reporter in Vietnam.

I went over to Vietnam eight times as a reporter. A reporter's job is basically to report, because you are not part of the fighting where you devote your whole heart and soul to the narrow focus of the effort at hand. Instead, one can step back and observe the big picture, which I did. As I pointed out to my friend John McCain, now a distinguished Senator, his view of Vietnam was always from an air-conditioned cockpit, his last land touch would have been at Subic Bay, until he found himself with a broken body drowning in the lake on enemy territory.

Some of the pilots, when they bailed out, hanging in their chutes, realized that this place smelled like manure. Which it did. Human manure. It is a big switch from the cockpit to the ground.

I said although you know more than I do about the psychology of Communist prison guards, John, you have not seen Cambodia, Laos, three-core, four-core, two-core mountain areas. I have been out on Yankee Station with your brother pilots. A big overview I got of this thing.

So I came back with the feeling that all we were doing in Vietnam was tearing the flesh and blood off one another's young men with shrapnel. That was basically the level of combat. It nauseated me. Half of those trips I forced myself to stand in morgues. I remember one vividly where I cried because here were green hefty bags with remains in them, and a larger bag of amputated arms and legs, off in the corner, that we were going to bury at sea by helicopter. So they said we even have respect for our men's amputated limbs. I asked, and the enemy limbs? Oh, that's that bag, because we do technical surgery with no prejudice on enemy soldiers captured.

I came back from this and heard Jane Fonda. She was very naive at the time, but Tom Hayden was speaking through her, a leader in the California Assembly at this time. She accused us of bombing population centers in Vietnam. It was not true. I have been an eyewitness to this, and they assumed it was true—that the cliche

World War II actual scene and then highly cliched in movies, of the weather officer coming in usually with a British accent: "Navigator, lead navigator, coming in with navigation briefing." But then the ops officer comes in and says: "I have bad news for you. We are not going to be able to hit our primary targets today, which of course are hospitals, schools, orphanages, churches, temples and population centers." Whereupon a groan goes up in the room, in this fictitious scene. "We are going to have to hit our secondary targets, petroleum and oil depots, MIG bases, which were banned by MacNamara, and military targets and maybe a few truck parts along the Ho Chi Minh Trail."

Now, that is idiotic what she said. It was a foul, unfair charge.

But it hit me one day while campaigning in 1976 before I was a Freshman that her unfair charge to our planners and the implementors of those plans and the young men that flew the missions, that that charge was precisely correct strategically. That here we were under mutual assured destruction, targeting—Jane Fonda had five categories plus a chocolate factory, believe it or not—schools, orphanages, old people's homes, hospitals and churches. Those are the five categories.

I said, we are not only targeting those five categories, as with Hamburg, basically a British raid; Dresden, mostly British but U.S.; or Tokyo, all U.S.-created firestorm. We are targeting those five and everything else in between.

Under mutual assured destruction we were violating any moral precept that had ever been applied to this ugly curse called warfare. We were targeting innocent civilians. The young, the old, the infirm and everything in between.

I then decided that if I was able to share in this type debate, I would partake in them. I have fought for 12 years to be a recently assigned member of this committee and I believe these discussions are important.

Because as the Chairman says so eloquently on the House floor, this is the essence of whether or not we are humans or "animals" and what separates us from all of the history before us that has so much brutality attached to it, including El Salvador, which I just returned from over the weekend.

Now, if mutual assured destruction is morally, ethically flawed, and the Episcopalian Bishops rose to this first, followed by most Rabbinical groups, and then the Catholic Bishops, really driven by one humble priest as he describes himself, Brian Hare.

Dr. CODEVILLA. I do not know about the first part.

Mr. DORNAN. Right. Well, we always pose as humble when we are very, very, very bright, even someone as bright as Charlie Bennett.

This strategic defense concept has always appealed to me, Mr. Chairman, for two reasons. One, it is returning from the obviously indefensible, immoral policy of mutual assured destruction to a mixture of offense-defense. But the main appeal technically is the deterrent impact, what I previously said to Charlie, destroying 90 percent of the temptation to attack.

If we are living in a very real world where none less a source than Plato said only the dead have seen the end of war—I just returned from watching three journalists killed trying to observe a

limited intensity war—we are going to have to figure out in precise terms what is the best deterrent and the most moral.

Certainly other than trying to build walls and dig moats while someone is breeding a million horses like the Huns, the mix is what we are driving toward rather than the, I believe, indefensible immorality of a MacNamara total mutual assured destruction policy of what Jane Fonda incorrectly accused us of doing tactically in Vietnam.

So let me get to starting with Jimmy Carter's Presidential Decision 59 which I believe President Reagan gets credit for. Is that not the perception out there, that President Reagan changed all this?

Dr. CODEVILLA. It is.

Mr. DORNAN. Because he followed through on it.

Dr. DRELL. In my understanding, actually, we did have a lot of military targeting before then all along.

Mr. DORNAN. Yes.

Dr. DRELL. We had many more warheads than cities to target.

Mr. DORNAN. Right.

Dr. DRELL. So I think there was more continuity than big discontinuity at that moment.

Mr. DORNAN. Right.

Dr. DRELL. It was a recognition of something that had been evolving.

Mr. DORNAN. It was a change of emphasis of an evolution. Is that right, Dr. Drell?

Dr. DRELL. I think it was a change of sort of recognition publicly of what had been evolving all along, It is my understanding. Because remember at the time in 1980 we had in our strategic forces then in excess of 10,000 warheads of various sorts, and there were not that many city and countervalue targets.

Mr. DORNAN. Right.

Dr. DRELL. So you know that a number of them were targeted on military targets already. I think it was more of a recognition.

Dr. CODEVILLA. We did not have one bomb per city.

Dr. DRELL. No.

Dr. CODEVILLA. We had many, many bombs per city because again, for good or ill regardless of what rhetoric says, it is impossible to destroy a city with a single bomb.

We used to have, in the case of Leningrad, 111 bombs targeted on that city.

At any rate, the point is that I could not agree with you more. The choice that we had then, the choice that we have now with regard to offensive forces, is where to shoot. That is not a choice for the future. It is a choice for now. It is a choice that we have had for a long time and that no one can take from us.

If our purpose is to destroy weapons, if our purpose is to keep those weapons from being used against the United States. If our purpose is to make them useless as means of killing people or destroying things in the United States, then it makes sense to pursue that purpose by every means at our command.

We do not have certain capacities yet, nor perhaps will we ever have them. But we have some capacity now.

My point to this committee is, you ought to use such money as you can spare from other purposes for purchasing now such capacities as are now purchasable.

Thank you.

Mr. DELLUMS. If the gentleman would yield, I got a signal from Dr. Drell that apparently both of you have got to fly.

Dr. DRELL. Our airplanes are getting ready to leave.

Mr. DELLUMS. Let me, if I might, then, on behalf of myself and members of the committee, express our deep appreciation to both of you for journeying all the way from California. Dr. Drell and Dr. Codevilla, we appreciate your contribution. As I said earlier, it is an interesting juxtaposition, in my humble opinion, a very clear juxtaposition. It is through the clarity of both of your abilities to present your perspectives and points of view that I think a great deal has come out of this hearing. I think you have contributed enormously to our perception on this committee and we deeply and profoundly appreciate it.

We had a few other questions here, but you have pretty much answered all of them either extemporaneously or in anticipation of it. Again, we appreciate your contribution. Thank you very, very much.

Dr. DRELL. Thank you for the opportunity, Mr. Chairman.

Dr. CODEVILLA. Thank you, Mr. Chairman.

Mr. DELLUMS. Thank you. The Chair would like to indicate that this subcommittee will meet at 10 a.m. in 2212 on the University Research Programs.

[Whereupon, at 4:05 p.m., the subcommittee recessed, to reconvene at 10 a.m. the following day, Thursday, March 23, 1989, in room 2212.]

# DEFENSE RDT&E BUDGET REQUEST FOR FISCAL YEAR 1990

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HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
RESEARCH AND DEVELOPMENT SUBCOMMITTEE,
*Washington, DC, Thursday, March 23, 1989.*

The subcommittee met, pursuant to call, at 10 a.m., in room 2212, Rayburn House Office Building, Hon. Ronald V. Dellums (chairman of the subcommittee) presiding.

## STATEMENT OF HON. RONALD V. DELLUMS, A REPRESENTATIVE FROM CALIFORNIA, CHAIRMAN, RESEARCH AND DEVELOPMENT SUBCOMMITTEE

Mr. DELLUMS. The subcommittee will come to order.

This morning the Research and Development Subcommittee will continue its hearings on the fiscal year 1990 budget request. Our two witnesses today are Dr. George P. Millburn, Acting Deputy Under Secretary for Research and Advanced Technology, Department of Defense, and Mr. Jack E. Krings, Director, Operational Test and Evaluation, Department of Defense.

We have asked Dr. Millburn to testify specifically on the University Research Initiative Program and the requirement of Section 220 in last year's authorization bill that mandated that all university contracts be issued on a competitive basis.

As many of my colleagues may remember, the URI program was an initiative of Congress to help maintain an adequate science and technology base and to encourage U.S. graduate students to enter these fields of study. However, soon after it was initiated, concern was expressed over what some people felt was the unequal percentages going to certain States and a 14 percent cap was placed on how much could go to any one particular State. During committee hearings last year, agreement was reached to remove the cap and to direct a more equitable distribution of these funds.

In conference, that provision was replaced by an amendment by Senator Nunn that required all university research contracts, not just URI, to be competitive. Apparently Senator Nunn was concerned about the increasing use of earmarking funds for certain universities by some Members of Congress. The effective date of this amendment is October 1, 1989.

We have heard that this amendment has been causing difficulty not only with the University Research Initiative Program but for other university research endeavors by the department.

It is our hope that Dr. Millburn will go into more detail about the problems that this amendment has caused. I know that the de-

partment has been working on possible solutions to this dilemma and we are anxious to hear what they might be.

Dr. Millburn, we have received your prepared statement and it will appear in the appropriate place in the record. You may proceed in any manner you choose.

**STATEMENT OF GEORGE MILLBURN, DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING, OFFICE OF THE SECRETARY OF DEFENSE**

Dr. MILLBURN. Thank you, Mr. Chairman, ladies and gentlemen.

I would like to begin by summarizing our University Research Initiative Program, or URI, as we call it. I discussed URI and the geographical broadening before this subcommittee last April.

In response to Congressional requests accompanying the Authorization and Appropriations Acts, we prepared and submitted plans this year to increase URI activities for broadening the base and building infrastructure. This will reduce multi-disciplinary research from 90 percent to 60 percent by 1993.

As the first phase in implementing these plans, the Department began an Initiation Research Program at $5 million this year. We plan to grow the program to 15 percent of URI by fiscal year 1991 if initial results so warrant, creating a program with new starts each year.

To broaden participation in the program, we specifically targeted historically black colleges and universities, other minority institutions, and institutions that received less than $4 million in DOD research and development funding in recent years.

We envision 3-year awards with $50,000 to $250,000 per year which will emphasize human resources. We also will increase emphasis on instrumentation. We will encourage proposers to request major instruments and budget more for equipment than the 10 to 15 percent typically allotted within DOD research awards.

We think local commitment is important and priority will be given to proposals offering cost sharing. We also want to encourage coupling with other research centers and priority will be given to proposals including cooperative agreements with State and local governments, national and defense laboratories, industry or other research centers of excellence.

The first competition is now underway. It will close March 30, 1 week from today. Proposals generally arrive late in the last few days of any competition, but we distributed the announcement broadly and telephone interest has been high. So we expect good response.

This year's competition is in four technical areas: materials and structures; physical and structural acoustics; non-linear mathematics; and transport processes related to synthesis of advanced materials.

Next year's brochure is now in preparation, and other technical areas will be highlighted in that competition.

In addition to the Initiation Research Program, we have a new fellowship program this year. It was created by the DOD Appropriations Act and funded with $5 million from the URI program

and $5 million from Defense Research Sciences, the core 6.1 research program.

This almost doubled our level of effort in fellowships, although it did not significantly affect our overall support of graduate students because DOD and other research agencies generally support most students by assistant. In the DOD before this new program, this accounted for about 95 percent of graduate students which we supported.

We see merit in continuing this increased level of fellowship activity, and we currently are working with the services and DARPA, the Defense Advanced Research Project Agency, to identify sources of funds to allow us to do so.

It is important to remember that as we increase our fellowship activity, we must also ensure adequate support for the research required for those students to actually get their digress. Fellowships support living expenses, tuition and the like, but research for the degree generally costs a great deal more when educating a science or engineering graduate student.

In addition to the two statutory requirements to fund fellowships and geographical broadening of the program, we were asked to submit to Congress this year a plan for the out years.

Specifically, we were asked to increase emphasis on activities to build a nationwide infrastructure for science and engineering education. This plan, submitted in February, includes funding in the outyears for research instrumentation and a new program to draw promising young scientists into oceanographical education.

We see merit in increasing URI activities to build a broader base of university research and education infrastructure. We also see merit in multi-disciplinary research which currently is emphasized within URI.

As I noted last year, multi-disciplinary research can accelerate progress in research areas that are suited to team effort. It can also speed transition of research to practical application.

I believe that we should maintain a strong core of multi-disciplinary research within the URI. The outyear plan we submitted maintains 60 percent of URI funding in multi-disciplinary research. When combined with our total 6.1 program, this is approximately 6 percent of the total 6.1 effort.

Finally, I want to again offer a word of caution about the need for stability in the URI and in all research programs. Research inherently is a long-term activity with pay-offs often coming only after extended periods of persistent inquiry.

We in the DOD stand ready to work with you to try to establish better, long-term stability in the program as well as to establish a good balance between multi-disciplinary research and other infrastructure building activities.

I hope that our outyear plan and today's hearing can serve as a basis for discussion on these matters.

Mr. Chairman, with your permission, I have some comments on another issue, the Section 220, and I will give those at this point.

Mr. DELLUMS. Please.

Dr. MILLBURN. DOD fully supports the intention of Section 220 to prevent set-asides for efforts not requested in our budget. However, problems will arise in applying Section 220 to a limited number of

efforts. These efforts have to do with relationships established between DOD components and certain universities over a long period of time.

Two of them involve Federally-Funded Research and Development Centers or FFRDCs. One is Lincoln Laboratory, which was established in the early 1950s and is contracted for by the Air Force with the Massachusetts Institute of Technology.

The second is the Software Engineering Institute, contracted for by the Air Force with Carnegie Mellon University as a result of an open competition a few years ago.

In addition, there is a Georgia Tech Research Institute contracted for by all three services. The Navy contracts with four universities on a non-competitive basis for four applied research centers.

The best known is probably the Applied Research Laboratory at Johns Hopkins University. Although it is possible that open competition could conceivably overturn one or more of these close relations, it is most unlikely. However, the uncertainty generated within these organizations could result in their losing some of their key personnel.

Further, one or more universities may not wish to compete for a facility subject to relatively short-term dissolution or could be restrained by State law or university policy against competing.

Section 220 also denies to the Department of Defense and any university community the use of exemptions provided in the Competition in Contracting Act or CICA.

We believe amending Section 220 to make it compatible with CICA will eliminate the concerns we have. This will place the universities on the same competitive basis as other contractors and would place the Department of Defense on the same contracting basis as other Federal agencies.

That concludes my remarks, Mr. Chairman.

[The prepared statement of Dr. Millburn follows:]

# THE DEPARTMENT OF DEFENSE

# STATEMENT ON

# THE SCIENCE AND TECHNOLOGY PROGRAM

BY

DR. GEORGE P. MILLBURN

DEPUTY DIRECTOR DEFENSE RESEARCH AND ENGINEERING

(RESEARCH AND ADVANCED TECHNOLOGY)

TO

SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT
OF THE
COMMITTEE ON ARMED SERVICES
UNITED STATES HOUSE OF REPRESENTATIVES
101ST CONGRESS, FIRST SESSION

MARCH 23, 1989

The FY 1990 and FY 1991 Department of Defense
Statement On
The Science And Technology Program

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Mr. Chairman and members of the Committee:

## I. INTRODUCTION

I am pleased to testify in support of the Defense Science and Technology (S&T) program for FY 1990 and FY 1991.

A strong national security posture is a combination of national resolve, industrial capability, morale, leadership, training and other ingredients. In addition, there is a pervasive need for superior equipment that can provide an edge over a range of combat situations. Fundamental to acquiring this equipment is the availability of technical options responsive to combat needs that can be the basis for developing increasingly effective systems. It is the task of the S&T program to provide the technical options that will enable the deterrence of future aggression and preclude adverse technological surprise.

A significant advantage the United States enjoys over potential adversaries is the existence of a broad, high-quality and innovative private sector, which also is a principal performer of the Department of Defense (DoD) S&T program. This is particularly important because industry is the ultimate producer of our equipment, and transfer from laboratories to production lines is facilitated when the developers of the technology are also the producers of its products.

Manufacturing technology and other industrial-base programs complement our S&T program by ensuring an efficient and effective transition from a new idea to a military product. In addition, our major allies have strong and innovative technology bases that further enhance our national security posture. However, a

technology lead is a perishable commodity, and the challenge is to maintain our lead and search for new approaches to create a more competitive edge.

As indicated earlier, the combat capability of our armed forces is determined by factors other than just the number of tanks, ships, planes and other weapons in the inventory. Our strength depends upon what our weapons can do: their accuracy, speed, firepower, reliability, etc. The Bradley fighting vehicle is much more capable than the armored personnel carrier it replaced. The Aegis antiair warfare system provides a dramatic increase in firepower and coverage when compared to older ships being retired. In addition, the new LANTIRN navigation system will enable our tactical aircraft to operate effectively at night and during reduced visibility. The technological progress we have achieved in these systems can spell the difference between success and failure in the battle arenas of the future.

The technology basis for these advanced systems was laid in the 1960s and 1970s. It was the forethought, planning and allocation of resources to a technological future in those times that has made possible advanced systems for use today. High quality people paired with superior weapons comprise the best formula for US security today and in the future. Therefore, it is imperative that we provide for that future now by pursuing a strong and innovative S&T program so that today's equipment can be replaced with increasingly more capable weapon systems that will be needed by us and future generations to ensure our national well being and sovereignty.

DoD S&T projects and programs range from fundamental investigations to the search for new techniques to proof-of-concept demonstrations for reducing technical risk and developing a sound basis for entering full-scale development. In budget

terms, the S&T program is made up of budget categories Research (6.1), Exploratory Development (6.2) and Advanced Technology Development (Budget Activity No. 2).

The Research (6.1) program provides the long-term foundation for technological progress. It is from this work that new ideas, innovative concepts, educational progress and technological leadership emerge. The US no longer enjoys an overwhelming research leadership position, and it is important that our universities and other institutions have the resources and facilities required for the country to march forward with technological confidence, both from military and economic viewpoints. For these reasons we afford special management emphasis to the DoD Research program.

The purpose of the Exploratory Development (6.2) program is to facilitate the translation of research results into military applications. For example, solid state electronics research provided the new phenomena that led to integrated circuits but more was required to satisfy a military need. The subsequent electronics developments resulting from those discoveries gave us the ability to sense, locate, acquire, track, identify and destroy targets. These were important contributions that emerged from the Exploratory Development program. In a similar manner, lasers, explosives, combustion, optics, medicine and fluid dynamics are typical disciplines that have provided the basis for laboratory personnel to develop effective techniques in kinetic energy weapons, munitions, aircraft, chemical defense and other essential military materiel. Collectively, these laboratory-developed techniques form the building blocks for future superior equipment.

The Advanced Technology Developments (ATDs) are the bridges that decrease the time to transition laboratory discoveries to

our forces in the field. They are one-of-a-kind demonstrations of systems, subsystems, components, etc., to determine military feasibility and utility. They are selected from promising candidates based on the probability of application to an existing or perceived need and the probability of success toward meeting that need. The ATDs provide a sound cost-effective means for demonstrating, against technological and operational criteria, the materiel that will make up future systems. Because the ATDs are carried out in realistic environments in the early phases of the development cycle they are of great value, at a relatively low cost, in providing realistic cost and technical risk estimates. We consider the ATD portion of the S&T program to be a sound investment.

In summary, our national strategy is based on continued reliance on a technology edge over potential adversaries. It is the most viable option we have and we must continue investment in the S&T program if we are to be successful in maintaining a dominant position in the increasingly sophisticated combat environments of tomorrow.

The current S&T program request for FY 1990 is $5,569 million and for FY 1991 it is $5,845 million. This total does not include the Strategic Defense Initiative amounts that are in the Advanced Technology Development category but covered in separate testimony. Table I outlines details of the request.

TABLE I

FY 1990-91 SCIENCE AND TECHNOLOGY PROGRAM

(Dollars in millions)

| | FY1989 | FY1990 | FY1991 |
|---|---|---|---|
| RESEARCH | | | |
| Military Departments | 725 | 818 | 850 |
| Defense Agencies | 231 | 112 | 113 |
| Total Research | 956 | 930 | 963 |
| EXPLORATORY DEVELOPMENT | | | |
| Military Departments | 1,565 | 1,572 | 1,614 |
| Defense Agencies | 957 | 791 | 837 |
| Total Exploratory Development | 2,522 | 2,363 | 2,451 |
| ADVANCED TECHNOLOGY DEVELOPMENT | | | |
| Military Departments | 1,400 | 1,642 | 1,585 |
| Defense Agencies | 891 | 634 | 846 |
| Total Advanced Technology Development | 2,291 | 2,276 | 2,431 |
| TOTAL SCIENCE AND TECHNOLOGY | 5,769 | 5,569 | 5,845 |
| Strategic Defense Initiative | 3,606 | 5,564 | 6,644 |

Note: A DoD budget review in process at printing time may alter the above figures.

## II. MANAGEMENT ACTIONS

Within the S&T program there are management activities and initiatives important to the conduct of an effective program. They are important because often they are the vehicles by which goals are achieved. These topics stem from both Congress and the Administration and are significant aspects of S&T program formulation and management. This section discusses some of these activities.

### A. Balanced Technology Initiative (BTI)

The Balanced Technology Initiative (BTI) is a technology development and demonstration program structured to accelerate progress in selected areas considered critical to conventional defense missions. Program efforts involving smart weapons technology are accelerating the development of fire-and-forget weapons that offer significant force-multiplier advantages, particularly for engagements at extended ranges. Work involving the collection of intelligence will enable more effective use of our combat forces by improving targeting capabilities and facilitating more efficient deployment of battlefield assets. Armor/anti-armor activities include development of affordable high-performance armor materials, advanced guns and projectiles, and new concepts, all intended to promote increased survivability and overall effectiveness of ground combat forces. Significant progress is also being made in the development of advanced mine concepts and mine detection techniques. Other BTI projects include work on high power microwaves, enhanced blast munitions, and technologies important to the development of advanced close air support aircraft.

The BTI is an important element of the DoD S&T program that facilitates the initiation of promising new work and accelerates the transition of technology into full-scale development. The BTI program is managed by the Office of the Director, Defense Research and Engineering, and the Director is the decision authority for initiating new projects. Specific projects are executed by the appropriate Service or Defense Agency, and multi-Service efforts are encouraged. OSD provides overall guidance and oversight to assure effective coordination with other conventional warfare activities.

B. The University Research Initiative

DoD initiated the University Research Initiative (URI) in FY 1986 to enhance university capabilities in research and in the education of scientists and engineers in fields of importance to national defense. Between FY 1986 and FY 1988, about 90 percent of URI funds supported multidisciplinary research. The remaining 10 percent of FY 1986-1988 URI funds supported "people programs," including graduate fellowships, young investigator awards, and scientific personnel exchanges.

DoD reduced URI's emphasis on multidisciplinary research in FY 1989 as a result of two provisions in the Defense Appropriation Act, 1989. In response to one provision, DoD allocated $5 million of FY 1989 URI funding for a new program of graduate fellowships in science and engineering. This program will increase the number of fellows funded by URI in the 1989-90 academic year from 260 to 355, about one-third of the estimated 1000 graduate students supported by URI.

In response to the second provision, DoD submitted to Congress a plan for broadening the geographical participation in the URI program. The Department currently is implementing the

plan by competing $5 million of FY 1989 URI funding for a new Research Initiation Program. This new thrust is designed to attract institutions that have capabilities to perform defense research, but may not have the breath of strengths necessary to assemble multidisciplinary teams. Proposals are being solicited specifically from institutions that have not been major recipients of DoD research and development funding in recent years, including historically black colleges and other minority institutions.

The DoD recently submitted to Congress a report, requested by the conference report accompanying the National Defense Act for Fiscal Year 1989, "for the eventual transition of the URI program from its current focus on multidisciplinary research to the broader focus of enhancing the nationwide quality of science and engineering graduate education balanced with multidisciplinary research." As the first phase of the transition, the Research Initiation Program will grow from about 5 percent of URI in FY 1989 to about 14 percent in FY 1991, if initial results so warrant.

In the second phase of the transition, investments will increase in "people programs" and university research instrumentation programs beginning in 1992 as the current multidisciplinary URI projects approach the end of their initial five year commitment. At the conclusion of the two phases, multidisciplinary research will have decreased from about 90 percent in FY 1986-1988 to about 60 percent in FY 1993-1994 with a corresponding increase in other infrastructure activities.

C. Independent Research and Development (IR&D)

IR&D continues to be an important component of the nation's total research and development program. In addition to "hedging"

DoD-sponsored research, company-selected, company-sponsored IR&D efforts provide DoD with a national pool of well-qualified contractors needed for future developments. The vitality of the program has been demonstrated in that almost all modern military systems have at least some IR&D roots with components already available because of prior IR&D funded developments.

The Department continues to seek ways to improve the IR&D process by removing impediments to its productivity. The removal of the IR&D cap and its replacement with a DoD target has allowed much-needed flexibility in managing the program. Further improvements are under consideration including initiation of a two-year cycle to reduce administrative burdens. As soon as details are worked out, it is planned to implement the two-year cycle. In addition, the use of electronic information processes to accelerate evaluations and other administrative actions is planned. The IR&D program is considered essential to provide competent, competitive contractors and innovative technology

D. Transferring Technology to Deployed Systems

Very little, if any, military benefit can be derived from technology achievements that remain in the laboratory. Therefore, enhancing the incorporation of new technology into our weapon systems is one of our principal goals to improve the acquisition system. Often the availability of technology is not consistent with windows of opportunity for application. In addition, demonstrated technology is not always readily producible, and current or projected warfighting doctrine does not always include integration of new concepts into the force structure. Effective technology transition requires close cooperation between the users, requirements and development communities in order to be successful.

The entire process of technology transition is as variable as technology itself. We are not so naive as to believe that we can resolve the entire problem with one grand solution. Rather, we view it as a continuing process in which substantial progress is being made. Our opportunities are enhanced because the larger portion of our research and development is performed under contracts and grants and also under the auspices of the IR&D community. Thus, many of the organizations that develop our technologies also produce our weapon systems, providing a relatively favorable climate for technology transfer. We will continue to accelerate the introduction of advanced technology into our weapon systems whenever it provides us an advantage in availability, affordability or performance.

E. Investment Strategy

Anticipated warfighting needs, recognized deficiencies and changing threat projections determine to a large extent the elements of the S&T program. It is necessary that the program be responsive throughout the full spectrum of conflict from low-intensity operations to global conflict.

We have recently strengthened our planning process. In formulating the S&T program, the Services and Defense Agencies together with OSD determine technology needs to provide future military capabilities. These capabilities are identified through guidance provided by the Secretary of Defense and the Joint Chiefs of Staff, as well as threat analyses and projections. Investment strategies are then developed that are coordinated across the Components to resolve differences, to assign lead responsibilities, to identify missing elements and to set priorities with respect to the goals established. It is our plan to have this process in place during the FY 1992-94 planning and budgeting cycle.

F. Critical Technologies

Public Law 100-456, The National Defense Authorization Act, FY 1989, requires the DoD to submit annually, and not later than March 15 of each year, a Critical Technologies Plan, to develop technologies most essential to ensure the long-term qualitative superiority of US weapon systems, with the first plan to be submitted in 1989. It should be noted that the planning process discussed above will provide, as a natural byproduct, a rapid update of the Critical Technologies Plan on an annual basis.

III. TECHNOLOGY PROGRAM

As indicated earlier, the DoD S&T program develops options for improved warfighting capabilities. The broad scope of these options not only requires that we pursue a multitude of technical disciplines, but also that the technology developed be used in multiple applications. We traditionally manage the program by technical discipline or area. However, in order to ensure a coordinated investment strategy and comprehensive program, we aggregate technology areas into clusters. The technology clusters are outlined in Table II.

The significance of a balanced S&T program cannot be overemphasized. An effective S&T program must be well-proportioned with regard to technology mix. For example, superior weapon systems demand superior simulators for crew training, and superior main battle tanks require superior river bridging capabilities. Also, sound environmental understanding and predictions are required to permit effective use of most systems. In addition, we must maintain activity in core technologies, such as materials and microelectronics, in order to cope with increasingly difficult military applications.

TABLE II

SCIENCE AND TECHNOLOGY PROGRAM

WEAPON CLUSTERS

- o WEAPONS TECHNOLOGY
  - Tactical Missiles Guidance and Control Technology
  - Target Acquisition and Fire Control Technology
  - Torpedoes and Undersea Warfare Weaponry Technology
  - Gun Technology
  - Bombs and Clusters
  - Landmines, Landmine Countermeasures and Barriers
  - Directed Energy Weapons
- o VEHICLE MOBILITY TECHNOLOGY
  - Aircraft Propulsion Technology
  - Missile and Space Vehicle Propulsion Technology
  - Aeronautical Vehicle Technology
  - Avionics and Vehicle Electronics
  - Land Mobility Technology
  - Ocean Vehicle Technology
- o ELECTRONICS
  - Command/Control/Communications Technology
  - Search and Surveillance Technology
  - Electronic Warfare Technology
  - Electronic Device Technology
- o ENVIRONMENTAL and LIFE SCIENCES
  - Environmental Sciences
  - Environmental Quality Research and Development
  - Training and Personnel System Technology
  - Medical and Life Sciences
  - Chemical and Biological Defense
- o SUPPORT TECHNOLOGY
  - Logistics
  - Materials and Structures
- o SOFTWARE AND COMPUTER TECHNOLOGY
  - Software Engineering
  - Machine Intelligence
  - Computer Systems Engineering

Because of the number and diversity of projects in the S&T program, only representative ongoing activities are described in the remainder of this section beginning with the underpinning for all technology, the Research program:

A. Research

In the short span of this century there have been remarkable scientific and technical advances that have profoundly altered military strategy and tactics. Examples include radio, radar, computers, antibiotics, nuclear weapons, jet engines, guided missiles, microelectronics, lasers, satellites and smart weapons. Few of these advances could have been foreseen. Similarly, it is unlikely that it will be possible to anticipate explicitly what equally revolutionary advances will occur in the next century. Nonetheless, DoD's research projects are designed to assure that this nation continues to be a source of fundamental scientific knowledge and has the basic understanding and awareness needed to apply new discoveries quickly and effectively.

A strong research program also ensures that the US will be adept at understanding and countering technological surprises should they occur elsewhere. From DoD's research program we expect discovery, understanding, visibility of scientific advances that occur outside the DoD, transition support, technical fixes and the production of scientists and engineers. These demands require coverage of the scientific and engineering disciplines both in breadth and depth.

Accordingly, DoD research programs include mathematics, computer sciences, chemistry, materials, electronics, geophysics, oceanography, biology and medicine. Examples of current activity in a few of these disciplines are as follows:

o Chemistry. Noteworthy progress has been made in propellants and explosives that promise greater range and more effective warheads for missiles.

o Electronics. The quest for ever-faster, smaller-size, lower-powered electronics continues. Examples where progress is rapid include adaptive antennas, fault-tolerant microelectronics systems, ultra-high-speed superconducting analog/digital converters, integrated optoelectric circuits and electronic devices with quantum-sized features.

o Atmospheric and Ionospheric Behavior. It is important for military systems to operate no matter what conditions are imposed on them by nature. Understanding and predicting the atmosphere and ionosphere are necessary if that goal is to be achieved. Examples where progress is taking place include remote sensing, satellite and radar meteorology, arctic weather, tropical cyclone motion and interaction of electromagnetic waves with the ionosphere.

o Cognitive and Neural Sciences. In the cognitive sciences there is movement toward seeking greater understanding of neurological structures and mechanisms as a basis for understanding cognitive phenomena. Also, collaborations are underway between computer scientists and electronics engineers. They are developing artificial neural networks that offer potential for enhancing the abilities of computers to learn, to recognize patterns and to synthesize speech.

B. Weapon Technology

The weapons technology program provides for across-the-board improvements in non-nuclear weapons. It addresses the development of technology for guided missiles, mines, torpedoes,

guns, ammunition, and directed energy weapons. Of particular importance is the development of technology for precision, autonomous, stand-off conventional weapons that will contribute toward the enhancement of deterrence and vast improvements in US warfighting capacity.

o Brilliant Weapons. These weapons operate autonomously and are capable of selectively identifying, engaging, disrupting, or destroying targets at considerable standoff distances in adverse environments. The technology is directed toward the development of target recognition methodologies and of multimode sensors (electro-optical, infrared, millimeter wave, etc.), combining both passive and active operating modes. The anticipated increases in military capability provide us the ability to:

- Attack several targets within a large target complex with weapons fired in a single pass.
- Maneuver defensively or engage another target immediately after a weapons launch.
- Increase survivability by launching weapons at long standoff distances prior to target lock-on.
- Attack targets effectively in adverse weather and in severe electronic warfare conditions.

o Electric Gun. Developments of electrothermal guns, railguns, coilguns and related power generation technologies promise substantial increases in performance for tactical systems by the turn of the century. Current efforts are directed toward the selection of an optimum concept by FY 1991. A vehicle-mounted, large-caliber electric gun demonstration is planned by FY 1995. The advantages of an electric gun include:

- Multiple applications including anti-armor, air defense and artillery.

- Increased lethality against ceramic and reactive armor at increased ranges.
- Reduced logistics burden because of smaller projectiles and the elimination of propellants.

o Advanced Torpedoes. The United States and the Soviet Union have been moving toward powerful submarine forces that are becoming increasingly difficult to detect and defend against. Developments underway include warheads, drag reduction techniques and guidance and control technology for the next generation of torpedoes. These torpedoes will be capable of operating over longer ranges with increased speed, reduced weight and with reduced acoustic signatures. These future torpedoes will:

- Embody target discrimination, aimpoint selection, and countercountermeasure capabilities.
- Exhibit enhanced probability of kill and reduced attrition against the advanced Soviet submarines.

o Directed Energy Weapons. The directed energy program is developing technology for high-energy laser, high-power microwave, and charged-particle-beam devices. Also, the program addresses hardening of our equipment against hostile directed-energy weapons. These weapons could have a major impact on warfighting doctrine because of their rapid targeting and multiple shot capabilities. Progress in directed energy weapons technology could provide the following capabilities:

- Practical antisatellite weapons.
- Protection of military systems from high-power microwave attack.
- Mobile laser weapons for tactical engagements.
- Robust electronic countermeasures using high-power microwaves.

- Hard target destruction with using charged-particle-beam weapons.

C. Vehicular Mobility Technology

This cluster includes land, sea and air vehicles and their related propulsion and electronics technologies. Because vehicle platforms represent the largest single investment category in the defense budget, our programs are focused not only on attaining increases in capability, but also on making future vehicles more reliable and affordable. Highlights of our vehicle technology program include:

o Integrated High Performance Turbine Engine Technology (IHPTET). Historically, propulsion system performance has had the single largest impact on aircraft combat capability as well as life-cycle cost. The IHPTET program is directed toward doubling propulsion system performance by 2005 through a three-phase plan that allows for maximum technology transition to nearer term new or upgraded systems. The specific goals are: a 100 percent increase in thrust/weight ratio and a 50 percent reduction in specific fuel consumption for turbofan/turbojet engines; a 100 percent increase in power/weight ratio and a 40 percent reduction in specific fuel consumption for turboshaft/turboprop engines; and, a 100 percent increase in thrust/airflow and a 40 percent reduction in specific fuel consumption for expendable engines. These goals are to be achieved while maintaining the same life goals as those for engines currently in development. In addition, a reduction in the number of parts will provide for better maintainability and reduced life-cycle costs. Illustrative capabilities provided by the accomplishment of these goals would be:

- An intercontinental range cruise missile of the ALCM size.

- A sustained Mach 3+ capability in an F-15 size aircraft.

- A 100 percent increase in the range/payload capability of a CH-47 size helicopter.

- A supersonic short-take-off-and-vertical-landing fighter of F-15 size with greater range/payload capability.

o Combat Vehicles. The size, weight, mobility, survivability and cost of land combat vehicles are quite sensitive to advances in basic vehicle technology such as high-density power packs and concepts that reduce turret and crew sizes. We are pursuing efforts to develop and demonstrate by 1993 technology that will substantially decrease under-armor volume requirements, vehicle signatures, and operating costs. Accomplishment of the following goals would provide, for example, a 55-ton tank that has greater firepower and is more survivable than the M1A1 (65 tons) and that costs substantially less to operate and support:

- Fifty percent reduction in power-package volume by means of a high density propulsion system based on either a gas turbine or a diesel engine.

- Fifty percent reduction in turret volume by eliminating the need for a man in the turret.

- Reduction of the space needs of the suspension system by means of hydropneumatic equipment.

- Ten percent reduction in track weight and a 40 percent increase in track life.

- Substantial reduction in visible, infrared, and acoustic signatures.

o Avionics and Vehicle Electronics. Current activities are directed toward technology for highly integrated and reliable avionics to permit maneuver and attack over varying combat environments. Technology projects include integrated

heads-up displays, auto-target recognition, nap-of-the-earth inertial navigation and major increases in avionics reliability. Successful achievement of these goals will permit:

- Conducting air operations under night or adverse weather conditions.
- Reduced crew workloads while improving situational awareness.
- Nap-of-the-earth navigation without detectable emissions.
- High reliability, multiple sortie missions without the need for frequent repairs.
- Coordinated movement and massing of firepower for ground combat vehicles.

o Ocean Vehicles. Ships and submarines typically have a payload fraction equal to 20-25 percent of their gross displacement. The remainder of the basic vehicle consists of the hull, propulsion system, and auxiliary equipment. Advances in the related technologies have a significant influence on the size, cost, and capability of ocean vehicles, and by virtue of the importance of ocean vehicles in the force structure, on force capability as well. Technologies are being developed to reduce auxiliary machinery weights, improve propulsion system performance, reduce hydrodynamic drag, reduce vehicle signatures and increase survivability. Specific milestones include:

- Thirty percent reduction in ship propulsion fuel consumption by 1995 through use of an intercooled, recuperated gas-turbine engine and electric drive.
- Thirty-five percent reduction in fuel consumption for ship-service power by 1995 through integral propulsion/ship-service power systems.
- Thirty percent structural weight reduction for both ships and submarines by 1992 through advanced materials development and structural design concepts.

- Twenty to thirty percent reduction in auxiliary machinery weight for both ships and submarines by 1992.
- Reduction of radar, infrared, and acoustic signatures by 1992.
- Reduction of hull and track weight and improved propulsion systems for amphibious vehicles by 1990.

Accomplishment of these goals would provide, for example: destroyer class ships with improved survivability and a 50 percent increase in range or a 20-25 percent reduction in displacement; greater survivability and combat payload in submarines; and amphibious assault craft that allow a 300 percent increase in stand-off range.

o National Aero-Space Plane (NASP). The purpose of the NASP program is to develop, and then demonstrate in an experimental flight vehicle, the technology required for military and civil vehicles capable of operating at sustained hypersonic speeds within the atmosphere and/or as space launch vehicles delivering payloads into orbit. The experimental flight vehicle is currently envisioned to be a horizontal take-off and landing, single-stage-to-orbit craft. If successful, the NASP program will be the basis for a new class of superior military aircraft and space transportation systems.

The NASP program is conducted jointly with NASA, with policy, guidance and broad programmatic direction provided by the NASP Steering Group. The NASP program is currently in the technology development phase. The experimental flight vehicle phase may begin in 1991 if technology development warrants. Current activity includes:

- Airframe configuration studies by three contractors.
- Engine concept development and preliminary ground testing by two contractors.

- Development of the required lightweight, high-strength, high-temperature materials by a consortium of five NASP contractors.

- Development of computational fluid dynamics codes and applications by NASA, the contractors and other research organizations.

Past investment in vehicle mobility technology has provided US forces with the world's most capable combat aircraft, quietest submarines, and most effective main battle tanks. Current programs in vehicular technology will insure that we maintain a decisive edge in future combat arenas.

D. Electronics Technology

Rapid and accurate collection and dissemination of information is essential to success on the battlefield and is a key factor when engaging numerically superior forces. Also, the ability to disrupt enemy communications and fire control systems can provide a decisive combat edge. Highlights of electronics activities include:

o Integrated Command/Control/Communications for Combined Forces. An important capability is the need to synchronize fighting units of combined forces with near-real-time interoperable C3 systems. Our lead in computers, communications and related technologies provides a strong base for developing a fully integrated near-real-time communications system. Goals include techniques that will link multiple battlefields, provide modularity, increase flexibility and improve operational decision aids. The development of these capabilities could provide:

- Automatic communication links regardless of distance,

- Assured reliability against hostile countermeasures.



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- Low probability of intercept communications.
- Dispersion of force and command posts with potential reduction of the force structure.
- Decision support (artificial intelligence) assistance to force commanders.

o Surveillance Technology. Longer range and over-the-horizon weapons require improved surveillance for both offensive and defensive capabilities. Advances in this technology will make significant improvements in the performance of platforms operating in land, air, space, air-ocean interface and subsurface environments. Developments will provide for;

- Improved capabilities in detection, classification and tracking a variety of threats in operating environments.
- Active and passive systems to counter the next generation of submarines, aircraft and other vehicles in adverse as well as benign environments.

o Bistatic and Synthetic Aperture Radar. Bistatic radars (separate transmitter and receiver locations) have greater ability to function in the face of higher density electronic countermeasures and anti-radiation missiles. Synthetic aperture radar, on a penetrating platform, will provide an all-weather means for automatically detecting, identifying and locating second echelon forces. Attainment of these goals will provide for:

- All-weather detection, tracking and classification of low-observable targets.
- Detection and classification of stationary targets possibly obscured by foliage.
- All-weather information on second echelon forces hidden from long-range, stand-off sensors.
- Reductions in sensor cost and weight.

o Electronic Warfare. Future battlefields will contain a very large number of complex electronic signals that span the frequency spectrum. US command, control, communications, and sensor systems must coexist with allied and hostile electromagnetic emitters, making management of electronic warfare an essential but extremely difficult aspect of combat. Electronic warfare goals include a 100 percent improvement in power output-to-system density, survivability concepts at affordable cost and the development of generic countermeasures that negate entire classes of threats without the need for detailed intelligence or specific design data on hostile emitters. Attainment of these goals will provide for:

- The ability to operate with a low probability of detection but with awareness of allied and opposing force locations.
- The performance of missions in dense electronic warfare environments with acceptable attrition.
- The disruption, exploitation, and destruction of critical C3 nodes and sensors, thereby denying hostile forces intelligence and coordination abilities.

o Electron Device Technology. Electron devices continue to achieve greater performance levels while, at the same time, providing for better reliability, smaller sizes and lower costs. We are continuing to make investments in the microelectronics, microwave/millimeter wave and electro-optical areas because electronic devices will continue to be critical elements in most future weapon systems. In addition, greater emphasis is being placed on manufacturing productivity improvements that will benefit both the defense and commercial communities. Achievement of our goals in this area will provide for:

- Advancements in integrated circuits, at 0.5 micrometer feature sizes, that will permit higher functional

complexity, greater speed, radiation hardness and reduced life-cycle costs.

- Development of 1 to 100 GHz transmitter, receiver and detector circuits for use in advanced radar, electronic countermeasures and communications equipment and brilliant weapons.

- Establishment of a production base for affordable infrared focal plane array sensors that will meet the burgeoning needs of space surveillance and tracking and tactical weapon targeting.

- Development of semiconductor manufacturing technologies that not only will help us meet military needs but also will be the basis for establishing world leadership in a technology important to industrial competitiveness.

E. Environmental and Life Sciences

This cluster addresses technologies that are critical to the successful operation of modern weapon systems and to the command decisions that often dictate the outcome of battles. Efforts are conducted in environmental sciences, training, personnel, medicine, life sciences and chemical/biological defense. Our current activities include:

o Target Area Environment Characterization and Prediction. Weather and obscurant conditions are significant factors in the effective use of otherwise perfectly operating "smart" weapons. Efforts are being pursued to develop the technology for combat weather determination and prediction, multi-spectral data sources and simplified weather depiction techniques. These aids will provide support and give battle commanders decision options at all command levels on land and at sea. Accomplishment of these objectives will provide for:

- Optimum use of combat resources.

- Increased operational effectiveness under adverse weather or obscurant conditions, including capabilities to distinguish dim targets in clutter situations.
- Increased survivability in a nuclear, chemical or biological environment.
- More effective use of environmental conditions as a factor in planning and executing military operations.
- Improved weather and terrain data integration for making tactical decisions.

o Space Environment and Hazards. Spacecraft systems and personnel experience hazards in the space environment because of interactions with energetic and charged particles. Spaceborne sensors are adversely affected by naturally occurring and man-made infrared and ultraviolet backgrounds. Efforts are underway to develop technology to provide hazardous condition warnings, solar forecasts and an automated spacecraft electric discharge control system. In addition, means are being developed to better define atmospheric/celestial background clutter for improved spaceborne target surveillance, detection and tracking. Accomplishment of these objectives will provide for:

- Increased survivability of advanced microelectronics in space systems.
- Automated defense against damage from spacecraft electrical charging.
- Reduced risk to manned operations in space.
- Improved space target detection with fewer false alarms.
- Improved detection for low-observable vehicles in the atmosphere.

o Ocean Environment Exploitation. The undersea world differs radically from the atmospheric environment. Dynamic conditions of the undersea world have a pronounced effect on the

ability of sensors and weapons to counter the threat posed by the latest generation of quite submarines. It is essential that our understanding of the undersea environment be increased to:

- Shorten the processing time for large acoustic systems.
- Improve the spatial resolution of acoustic systems.
- Better predict the rapid changes in the undersea conditions in order to optimize the effectiveness of all classes of sensors and weapons.

o Combat Casualty Care. Minimizing battlefield casualties is essential for sustaining combat operations. The best use of medical resources will enhance survival and return casualties to duty rapidly. Major payoffs expected from current activities include:

- A powdered universal blood substitute.
- Concentrated blood volume expanders for battlefield treatment of hemorrhagic shock.
- Improved treatment of combat burn injuries.
- Therapies to prevent major organ system failure after injury.
- Rapid diagnostic tests for detecting septic shock.
- Liquid dressings for improved treatment of combat wounds.
- A computer-based diagnostic and treatment system for use in isolated areas.
- Methods of adapting individuals to cold weather exposure prior to deployment.
- On-site production of oxygen and resuscitation fluids.

o Integrated Life Cycle Design. Weapon system design includes not only consideration of the hardware, but also the people (manpower, personnel, training, and safety--MPTS).

Current activities are directed at the development of computer based-interactive engineering design tools to integrate MPTS factors into weapon system design at the engineering work station. Realization of our goals in this area will provide for:

- Reduction in weapon field test failures with operational personnel.
- Increased sustainability of new weapon systems.
- MPTS availability and cost trade-offs during early phases of the acquisition cycle.

o Chemical and Biological (CB) Defense. The threat of potential adversaries using CB weapons is greater today than at any time in the past 50 years. Accordingly, we are pursuing the development of concepts, methods and materials for the detection, identification, decontamination of, and protection against known and future chemical and biological agents. In addition to more effective filters and clothing materials, more efficient microprocessor-based detectors, using spectrometry and biotechnology techniques, are being developed. The following payoffs are expected:

- Point sampling alarms to classify and measure concentrations of nerve, blister, toxin, and pathogen agents.
- Laser stand-off detectors with a total chemical-contamination reconnaissance capability.
- CB mass spectrometers to detect, identify, and determine concentrations of chemical and biological materials present in the ambient air as vapors, aerosols, or liquid droplets.
- Small economical CB monitors for shipboard spaces.
- Improved masks and collective protection systems.
- Improved chemical protective overgarment materials.

F. Support Technology

Support technologies are so pervasive that they are addressed in a separate cluster. Included herein are our efforts in materials and structures development (excluding electronic materials) and logistics technology. Logistics technologies cover weapon support including maintenance, diagnostics, and manufacturing processes. Our current efforts in these areas include:

o Materials and Structures. Materials and structures are enabling technologies that are fundamental to significant advancements in many mission areas. A new composite material provides the weight reduction and strength needed for a revolutionary cruise missile. A new adhesive permits development of space vehicle members that can withstand a rigorous environment and increase payload at the same time. And, an advanced material is the means by which a supersonic erosion resistant canopy is developed. The materials and structures program is concerned with structural components, thermal protection and functional materials. The program goals include:

- Development of protection against battlefield lasers for personnel, optical sensors, aircraft canopies and vehicle structures.
- Development of materials and structures for advanced turbine propulsion engines and hypersonic vehicle structures that will lead to a demonstration of an all-weather, highly-survivable, low-observable intercontinental cruise missile and weight-efficient, short-takeoff-and-landing aircraft.

o Diagnostics and Prognostics. Rapid diagnostics and timely prediction (prognostics) of component failures will increase availability of our weapons and become an effective

means for improving readiness and availability. Our goals are to develop:

- User-friendly electronic data bases to replace paper technical manuals.
- Computer-aided reasoning for rapid diagnostics and fault isolation.
- Embedded sensors signaling the need for maintenance before failure occurs.
- Self-repair by system reconfiguration based on in-flight diagnostics.

o Maintenance Information System. We are developing a computer-assisted approach to total weapon system maintenance. Technical data, training, diagnostics, management, scheduling and historical data bases will be linked together. A hand-held computer will provide flight line personnel with totally digitized technical orders and interface with on-board aircraft computers and large mainframe computers in the maintenance depots. We expect to demonstrate that integrated maintenance information systems can result in substantially reducing troubleshooting time and increasing maintenance accuracy.

G. Software and Computer Technology

The growing size, complexity and importance of computers in defense systems requires that we undertake both technical and management initiatives to improve our posture in this key cluster. The software and computer technology program is structured to provide increasing capabilities for emerging systems while at the same time reducing the cost and logistics burden associated with development and life-cycle maintenance of computer and software resources. Highlights of the computer and software technology program include:

o Software Engineering. Software engineering addresses the automated tools, methods and standards required for a disciplined approach to software development and maintenance throughout the life cycle of a system. Significant improvements in military capability will result from:

- Integrated software engineering environments that improve productivity and provide complete life-cycle software support.
- Standardized programming languages and inter-tool interfaces.
- Software reuse during weapon system development.
- Improved software intrusion protection and multiple levels of security procedures.

o Machine Intelligence. Advances in software and computer hardware make possible knowledge-based systems that could reduce the dependence on direct human involvement in many complex and dangerous situations. Potential applications include:

- Machine assistance in the human decision process.
- Increased use of robotic devices in both combat and other hazardous environments.
- More effective automated fault diagnosis and testing.

o Computer Systems Engineering. This technology includes work in systolic arrays, highly parallel systems, neural networks and optical processors. Also, the work involves advanced computer memories, display technologies, and interface and architecture standards. Benefits to be achieved from these programs include:

- Significant improvements in processing capabilities.
- Increased radiation hardness of computer systems.

- Increased survivability of command and control functions through reconfiguration of networks after disaster or combat damage.

IV. CONCLUSION

The S&T program over the past 40 years has gone through a number of major transitions. Immediately after World War II it was clear that technology had played a major role in shortening the conflict. It was natural and completely acceptable that the DoD (and also the Atomic Energy Commission which grew into the Department of Energy) should sponsor efforts in research, even when military applications might not have been obvious, particularly since there were few other federal agencies able to support research. Now the role of the federal government in sponsoring research, and some development, has greatly expanded and it is natural that the DoD by choice and Congressional direction should limit its research (and particularly its development) to potential military uses. This is the case, although DoD is cognizant of its responsibilities to encourage the application of its technology to non-military uses that will strengthen the nation's economic competitiveness and stature.

The DoD S&T program plays a modest but important role in the context of the total federal research and development program. Within federal support for research, the Department provides about 10 percent and 25 percent respectively for basic and applied research. Although the DoD Research, Development, Test and Evaluation appropriation is about 60 percent of total federal research and development obligations, the statistic is misleading because most of the program supports a full spectrum of developments to provide the tanks, aircraft, ships and other equipment needed by our forces.

The Department is committed to conducting a strong S&T program because a principal key to our military and economic strength is the pace by which we evolve and transition technologies to meet the needs of the country. It is our goal to ensure that the DoD S&T program is given special management attention to enhance that part of the national security effort that provides a foundation for the future.

Mr. DELLUMS. Thank you very much, Dr. Millburn.

Could you explain just specifically your recommendation that Section 220 be amended. You used an acronym there I am trying to learn.

Dr. MILLBURN. CICA, it provides seven conditions under which it is permissible for Federal agencies to grant contracts without going through open competition.

Mr. DELLUMS. Mr. Hochbrueckner? The Chair recognizes the gentleman for such time as he may consume.

Mr. HOCHBRUECKNER. Thank you. I am trying to appreciate the relationship of your program to others because obviously there is a tremendous amount of research going on.

For example, on page 18 of your report under Avionics and Vehicle Electronics, I am very interested in the relationship that your program might have with, for example, a program that I have been prolonging, x-ray lithography, which is the next generation of computer chips which will decrease to quarter of micron levels the present level of one and a quarter micron element sizes.

It seemed to me this is a program that the Congress has put in successfully into the budget the last 2 years. While the administration is very excited about x-ray lithography in terms of its potential for producing the next generation of computer chip, we didn't find any money in the DARPA budget this year for x-ray.

My question for you is in light of your particular charter and in light of your Avionics and Vehicle Electronics section, is it possible that funding for this kind of a program could, in fact, come through your particular budget?

Dr. MILLBURN. This is a program which is being executed by the Defense Advanced Research Projects Agency. They did not include in their budget submission funds for the program. However, they are coordinating their efforts with Sematech and with the IBM Corporation, which has the industrial efforts in the United States. They will be defending this when they testify before the subcommittee.

Mr. HOCHBRUECKNER. Well the problem is there is no money in the pot this year.

Dr. MILLBURN. That is correct.

Mr. HOCHBRUECKNER. The real issue is, is it possible from your particular funding that we could capture some money since obviously in this particular case the goals are coinciding in terms of what you are trying to accomplish in your group versus this direction. Recognizing that while this particular program has been placed under DARPA and has had an investment of $46 million over the last 2 years, only 12 percent of our computer chips are actually military. Eighty-eight percent are used on the commercial side.

So clearly this is a program that provides tremendous opportunities for the United States, both from a military as well as a commercial point of view. Clearly this kind of an investment makes a lot of sense.

Of course, we were all surprised to find 2 years ago that the Japanese, in fact, were exporting more computer chips than we, and we invented the technology. So it seems appropriate and logical we

should be back in the game. Obviously my problem is to go find some money.

We need close to $40 million this year to keep this program moving out smartly. So I am looking at every opportunity, and you seem like a great opportunity, sir.

Dr. MILLBURN. Thank you, sir. I will certainly look into that and report back to you.

[The following information was received for the record:]

X-RAY LITHOGRAPHY

We feel that x-ray lithography is an important technology for the future of our semiconductor industry. We are aware that advanced lithography is important to both military and commercial semiconductor production. Accordingly, we have developed three advanced lithography equipments on our Very High Speed Integrated Circuits program. These are the GCA 248 nanometer excimer laser optical lithography system for .35 micron linewidths, the AEBLE-150 direct write electron beam machine for .25 micron linewidths, and an x-ray step-and-repeat system. We are also developing a focused ion beam system that will be capable of direct ion implantation at 0.1 micron feature sizes without the need for a lithography system. These machines are projected to be able to meet both the near term and long range needs for low volume military semiconductor production.

Although we realize the importance of x-ray lithography, particularly to industry, the Department was unable to include funding for x-ray lithography in the fiscal year 1990 and 1991 budget. We believe the budget, as submitted, provides a reasonable balance between our needs and resources available to insure our future.

Mr. HOCHBRUECKNER. Thank you very much.

Thank you, Mr. Chairman.

Mr. DELLUMS. The gentleman yields back his time. Mr. Kyl is now recognized for such time as he may consume.

Mr. KYL. Mr. Chairman, I am sorry I did not hear all of the testimony, but in view of that fact, it probably won't be appropriate for me to ask any questions.

Thank you.

Mr. DELLUMS. Mr. Dickinson is recognized for such time as he may consume.

Mr. DICKINSON. Thank you, Mr. Chairman. I, too, arrived late due to several things, including a vote, so I will pass on any questions that we have and fill in later.

Thank you.

Mr. DELLUMS. Thank you very much, Mr. Dickinson.

Dr. Millburn, as you know, there were a number of requirements in last year's appropriation bill, reporting requirements, and one, the report listing requirements, projects and activities set aside for specific universities, which was required by the appropriation bill, and the due date was February 1, 1989, apparently that particular report has not gotten here as yet.

Can you fill us in as to the status of that report? What is the delay? Where are we and at what point can we anticipate that requirement being met?

Dr. MILLBURN. Yes, sir, Mr. Chairman. We have prepared a proposed response which is currently in review. I attempted to find out yesterday the exact status and was not able to. There has been an amount of uncertainty within the Department, but I feel sure that it will be on its way to the Congress shortly.

Mr. DICKINSON. Could I ask a question on that?

Mr. DELLUMS. Mr. Dickinson.

Mr. DICKINSON. The Chairman correctly stated the proposition. I think it started when we authorized some funds for university research and development, and then one of our colleagues from the Senate insisted that one of his universities be named by name. Then that led to just a proliferation of this type of thing to the point where, when we authorized in a blanket way when the appropriators got to it, everyone that has a university in their district named them specifically. They got this to go here, this to go here, etc.

So everybody was taking care of their own universities back home, which was not our intent. As a result, in our conference last year with Senator Nunn as Chairman, we said this is not the way to go, we are not going to authorize anything like this.

We directed DOD to come up with a plan so that everybody on the authorizing committee weren't preferring their home university to the detriment of the program and to the exclusion of all other members.

So it is important that DOD do come forward with a homogeneous plan. One that is broad enough to do the job and won't be preferring individual universities according to the committee assignment of the appropriators.

So I hope that is forthcoming soon before we get through with our mark. We want to have a chance to see it, approve it and make sure that what happened last year doesn't happen again.

Dr. MILLBURN. Thank you, sir.

Mr. DICKINSON. Thank you.

Mr. DELLUMS. Thank you.

Dr. Millburn, you mentioned that it was your recommendation that Section 220 be redrawn to be compatible with the competition and contracting out legislation.

Let me ask you this: Do you plan or anticipate sending us very specific language changes or provisions? If so, will that accompany President Bush's budget submittal? Will it be part of the general provisions?

Dr. MILLBURN. We are preparing a response now, and I believe it will be submitted separately from the budget, but it could, of course, be included if the Secretary decides to do so.

It is currently being reviewed within the Department.

Mr. DELLUMS. I see.

Do you have a time frame which we can anticipate that language coming over?

Dr. MILLBURN. I hope it will be within a few weeks and certainly before the middle of April.

Mr. DELLUMS. Just one other question.

Are you aware of any university-related programs that have been specifically earmarked in recent legislative action, and if so, could you please outline which programs these are?

Dr. MILLBURN. I would like to submit that for the record, if I might, Mr. Chairman.

[The following information was received for the record:]

UNIVERSITY RELATED PROGRAMS

Twenty-two (22) set-asides totaling $181 million for specific projects not requested by DOD are contained in various fiscal year 1989 statutes or committee reports. It

appears that not all of these are earmarked for universities; moreover, even in some cases in which a university appears to be the intended recipient, it is not possible to identify the institution intended from the statute or accompanying report. So as not to err through ignorance of the sponsor's intention, the response to this question lists those projects for which DOD did not request funds and which appear to be set-asides. The intended recipient is listed if the institution can be identified from the statute, accompanying report language, or colloquy, or if the set-aside is intended as follow-on funding for projects earmarked in a prior year.

Five (5) statutory set-asides totaling $43 million are contained in the fiscal year 1989 DOD Appropriations Act:

—Medical institute for research in immunology, $2 million, institution not specified.
—Bioenvironmental hazards research, $16.5 million; Tulane and Xavier Universities.
—Concurrent engineering, $20 million, General Electric including several universities.
—Stategic materials technology, $3.5 million, South Carolina Research Authority.
—National Center for Physical Acoustics, $1 million.

Five (5) statutory set-asides totaling $30 million are contained in PL 100-440, making appropriations for the National Defense Stockpile Transaction Funds administered by the Defense Logistics Agency:

—Biomedical Polymer Research Facility, $7 million, University of Utah.
—Stategic Materials Research Facility, $14 million, University of Hawaii.
—Stategic Materials Technology Transfer, $3 million, University of Texas.
—Stategic Research and Environmental Lab, $3 million, University of Idaho.
—Advanced Information and Resource Management Center, $3 million, Loyola College of Maryland.

Five (5) set-asides totaling $61 million are contained in HAC, SAC, and Appropriations Conference reports:

—Simulation and training technology transfer, $5 million, University of Central Florida.
—Optoelectronics materials R&D, $12 million, institution not specified.
—Advanced semiconductor materials, $20 million, State University System of Florida.
—Smart skin radar technology, $4 million.
—X-ray lithography, $20 million, Brookhaven and DOD laboratories.

Six (6) set-asides totaling $46 million were contained in Amendment 89 to the fiscal year 1989 Appropriations Act, reported in disagreement and subsequently eliminated by an amendment requiring a report on earmarking:

—Center for Management of Technology, $10 million, Auburn University.
—Center for Industrial Innovation, $7.5 million, Lehigh University.
—Institute for Intercultural Security Studies, $10 million, campus in District of Columbia.
—Minnesota Supercomputer Center, $7 million, University of Minnesota.
—S&T complex for manpower training, $10 million, University of Scranton.
—Advanced ceramic materials fabrication, $1.5 million.

One (1) set-aside totaling $1 million is found in the Senate Report on the fiscal year 1989 Military Construction Appropriations Bill and is earmarked for an aerospace medicine facility.

Mr. DELLUMS. I appreciate that.

Mr. DICKINSON. Is that because you don't have it ready or you just want to slide it under the door?

Dr. MILLBURN. I don't really have it ready.

Mr. DELLUMS. Thank you very much.

Mr. Pickett, the gentleman is recognized for such time as he may consume.

Mr. PICKETT. Mr. Chairman, I want to reserve my time, if I may. I don't have any questions at this time.

Mr. DELLUMS. Are there any questions from staff, any follow-up?

Dr. Millburn, thank you very much. If any additional questions occur to us, we will submit them to you in writing and hope you would respond in a timely fashion. Thank you very much for your contribution.

The subcommittee will now take testimony from our next witness, the Honorable John E. Krings, Director of Operational Test and Evaluation Office.

This office was created, as my colleagues well know, by the Defense Authorization Act of fiscal year 1984. Last year's appropriated budget for this office was approximately $71 million, and this year's request is $153 million.

Mr. Krings, I would like to welcome you for your appearance before the subcommittee and would appreciate a report card on how you feel your office is doing as well as to provide you an opportunity to explain the need for this 100 percent increase in your budget.

Most of the increase in your budget is in the "capability improvement line." I would appreciate knowing more specifically what capability you are planning to buy and some of the ways in which you are planning to acquire some of this capability. Last fall there was quite a discussion over the sources that were used by your office to acquire some of this capability.

We are in receipt of your prepared remarks and at this point they will be included in the record. You may proceed in any fashion you wish.

First the Chair would like to yield to my distinguished colleague from Alabama.

Mr. DICKINSON. Thank you, Mr. Chairman.

I know your job was created by the Congress, and by its very nature is controversial. It is a position we in Congress need to have filled, and I feel you have done this.

A current example of where the Congress looks to your office is the various programs that are being pursued in electronic warfare. As an example, last year authorization conferees directed that you develop a uniform set of standards and criteria for measuring radar warning receivers.

It is my understanding to date you haven't been able to furnish us with that request, and our goal is to have the various radar warnings developed for the Navy, Air Force and Army, with all of the tests in a similar threat environment, because that is the situation in which it would be used, with results from such standardized tests considered by the department and Congress so that the most effective decisions on which systems can be and should be procured would be made.

This is just an example of the type of effort we need from your office, and if you would comment on that among your other remarks, it would be appreciated. We are very pleased to have you with us today. Certainly your office is critical to what this committee is attempting to do, and what we view as our mandate.

Thank you for your appearance here today.

## STATEMENT OF HON. JOHN E. KRINGS, DIRECTOR, OPERATIONAL TEST AND EVALUATION, DEPARTMENT OF DEFENSE

Mr. KRINGS. Thank you very much.

Mr. Chairman, members of the subcommittee, I am pleased to have this opportunity to be with you today to discuss the work of our office, the Office of the Director, Operational Test and Evaluation [DOT&E].

I will essentially condense the written statement I gave, and I will try to address all the questions that you have all posed to me to be answered.

As you have already mentioned, we were established as a result of a congressional initiative in the Defense Authorization Act for fiscal year 1984. The office opened its doors in early 1984, and I became the first Director in April of 1985.

During the ensuing 4 years, we have conceived and championed a number of key policy resource and organizational initiatives. All of them are aimed at continuous improvement of the defense acquisition process through the discipline provided by early, ongoing and ever better operationally-focused test and evaluation, the ever better independent and timely reporting of the T&E results and assessments to the decision makers.

The measure of our success is customer satisfaction. Essentially, did the men and women in the field get what they wanted and needed when they wanted it and needed it? Does it do the job the users want it to do, and do the users consider it reliable and maintainable?

In mandating the establishment of our office, Congress recognized that an operational test oversight official, independent of the development and acquisition community, and with direct access to top DOD and congressional decision makers, is essential to improve customer satisfaction. He represents the customer.

I have interpreted to congressional mandate to mean just that; improved customer satisfaction, weapons systems and equipment that work when they need them, as they need them. This has required an activist approach with the obvious consequences of being an activist, involving the development of policies and techniques to permit the operational test community, the user's representative, to have early, independent and continuous insight into the progress of programs, to have the means of independently reporting its findings to decision makers in a continuous, life-of-the-program basis, and to have the resources it needs to gather meaningful information from which to derive its evaluations and assessments.

Both of you have suggested that we talk about the resources and how we get them, and we will talk about that. We have had significant success in all these areas, and there is great promise for continuous improvement on all fronts.

Working with the service operational and test agencies, the ones who actually do the testing and service, we have developed such assessment reporting tools as an early operational assessment and a systems maturity matrix.

These and other devices which we will discuss, I am sure in the questions and answers and assessment process, permit independent, objective, operationally-oriented evaluation of systems progress

toward meeting these user requirements at every stage during the life of the program.

In turn, this provides the substance for reports to decision makers at all major decision points and on a continuous status report basis. These go to the DOD decision makers, and they clearly go to the budget decision makers in the Congress.

When a decision is to be made on entering full rate production and fielding, our office prepares a detailed report, the so-called beyond low rate production or B–LRP report.

The report is made on the adequacy of operational testing and the operational effectiveness and suitability of the system or system components tested. By law, this report goes to the Secretary of Defense, the Under Secretary for Acquisition and the four defense committees of Congress; not through any of those, but directly to them without any intervention by any of them.

Status reports are provided in various ways, including our monthly operational test highlights that we send to the Congress and to many DOD people, our annual report, which is published in both the classified and unclassified editions, and a new mechanism, the Defense Acquisition Executive Summary, called the DAES, in which the Under Secretary for Acquisition is provided a snapshot look at the process of each major defense acquisition program.

We have made significant progress in the T&E resources area. Through a lot of personal efforts and a lot of efforts of the key people on our team, the President's fiscal 1990 budget includes a new consolidated DOD level funding line for test resources to significantly improve and update what is now a marginal national test capability.

This central test and evaluation investment program calls for investment of more than one and a half billion dollars in fiscal years 1990 through 1994 with about $175 million programmed for fiscal 1990.

The program will be managed by the Defense Acquisition Board Test and Evaluation Committee, established in 1987, to coordinate and oversee T&E resource and policy matters on a DOD-wide basis. It is a very dramatic and important step toward assuring that over the long term, we will have the test resource planning, management and investment necessary to evaluate the highly sophisticated systems that are now under development.

To cope with even more critical short-term gaps in operational test resources, we have implemented our own operational test and evaluation capability improvement program.

Begun in 1988, managed by our office and coordinated by the Test and Evaluation Committee, this program has given us the ability to accelerate quickly and cost-effectively acquire urgently needed test resources, including actual threat systems.

As the central T&E investment program comes on line, this gap-filling effort of operational test improvement gradually will be phased out and will be included in the total central test and evaluation investment program.

Organizationally, we have grown since 1985. When I took office, DOT&E had a staff of 11. That is due to the continuing interest and help of your subcommittee and the active support of the Secretary of Defense, and the Deputy Secretary of Defense.

We now have 52 staff members, a group large enough to be effective, and clearly we have all the people we need to do the job that we are supposed to do today. Also, we have recently established a Deputy for Strategic Systems, responsible for the oversight of T&E matters for all programs based upon the Defense Acquisition Board Strategy Systems Committee.

They have committees of tactical, strategic and $C^3I$, and we are essentially matching that in our oversight. We have also added a science advisor, a reliability and maintainability specialist and an information systems specialist.

The numbers of information system programs that we deal with in the Department of Defense are immense, at large cost, and are very important to the success of the more visible weapon systems programs. They assist our program oversight staff in the evaluation of test plans and results, provide expert advice to me personally and aid in the development of test and evaluation policy.

In addition to the science advisor and our staff, assistants for T&E policy and compliance are working closely with the service operational test agencies and the Defense Systems Management College to significantly improve the test and evaluation of program managers and other acquisition T&E officials.

It is much easier to acquaint them with test and evaluation when they are learning than after they have been in business for years. As I said at the onset, at the bottom, the role of the test and evaluation and acquisition process is to provide the discipline necessary to give the users the weapon systems and equipment that work the way they need them to, get them fielded when they need them.

To do this job we must be operationally oriented, continuous from the beginning and throughout every program's life, and above all, independently conducted, assessed and reported with candor and objectivity.

This is what our office seeks to bring to the table every day with the aim of continuous improvement of the defense acquisition process, improvement always being measured in terms of wiser production decisions leading to more customer satisfaction.

Do the men and women get what they want? Do they consider it reliable and maintainable? We ask these questions of ourselves every day. They form the standards by which we measure our fulfillment of the role of test and evaluation of the defense acquisition process.

Thank you, Mr. Chairman. I have some key members of the team with me today, and we will be happy to answer any questions you and the Members have, the subcommittee may have.

PREPARED STATEMENT OF HON. JOHN E. KRINGS

Mr. Chairman, members of the subcommittee--I am pleased to have this opportunity to be with you today to discuss the work of our office, the Office of the Director, Operational Test and Evaluation (DOT&E).

As you know, we were established as a result of a congressional initiative embodied in the Defense Authorization Act for Fiscal Year 1984. The office opened its doors in early 1984, and I became its first director in April 1985.

During the ensuing four years, we have conceived and championed a number of key policy, resource, and organizational initiatives. All of them are aimed at continuous improvement of the defense acquisition process through the discipline provided by early, on-going, and ever-better operationally focused test and evaluation (T&E), and ever-better independent and timely reporting of T&E results and assessments to decision makers.

The measure of our success is "customer" satisfaction: Did the men and women in the field get what they wanted and needed when they wanted and needed it? Does it do the job the users want it to do? Do the users consider it reliable and maintainable?

In mandating the establishment of our office, Congress recognized that an operational T&E oversight official, independent of the development and acquisition community and with direct access to top DoD and congressional decision makers, is essential to improved customer satisfaction. I have interpreted the congressional mandate to mean just that--improved customer satisfaction: weapon systems and equipment that work as the users want them to work, fielded when the users want them fielded.

This has required an activist approach, involving the development of policies and techniques to permit the operational T&E community--the users' representatives--to (1) have early, independent, and continuous insight into the progress of programs; (2) have the means of independently reporting its findings to decision makers on a continuous, life-of-the-program basis; and (3) have the resources it needs to gather meaningful informaton from which to derive its evaluations and assessments.

We have had significant success in all these areas, and there is great promise for continuous improvement on all fronts. Working with the Service operational test agencies, we have developed such assessment and reporting tools as the Early Operational Assessment and the Systems Maturity Matrix. These and other devices and assessment processes permit independent,

objective operationally oriented evaluation of system progress toward meeting user requirements at every stage in the life of a program.

In turn, this provides the substance for reports to decision makers at all major decision points and on a continuous, status-report basis. For program milestone decisions, the forum is the Defense Acquisition Board (DAB)--of which I am a permanent member--or the Service-level equivalent. When a decision is to be reached on entering full-rate production, our office prepares a detailed report (the so-called Beyond Low-Rate Initial Production, or "B-LRIP," report) on the adequacy of operational testing and the operational effectiveness and suitability of the system or system components tested. By law, this report goes to the Secretary of Defense, the Under Secretary for Acquisition, and the four defense committees of Congress. We also provide copies to a substantial number of interested DoD, Service, and congressional officials and staff.

Status reports are provided in a variety of ways, including our monthly operational T&E highlights letters to the Secretary, interested congressional staff, and others; our Annual Report, which is published in both classified and unclassified editions; and a new mechanism, the Defense Acquisition Executive Summary (DAES), initiated by the Under Secretary for Acquisition.

Our Annual Report is submitted to Congress in January or February. It includes detailed summaries and our office's assessments of operational testing conducted during the preceding fiscal year on systems under our oversight. In addition, we also present overviews of our progress and plans on the policy and resources fronts, with substantial backup information provided on key test and evaluation funding requests contained in the President's Budget.

The DAES, presented to the Under Secretary for Acquisition monthly, provides a snapshot look at the progress of a program. Each major defense acquisition program is covered in a DAES on a quarterly basis. Our office contributes an independent assessment of system progress toward operational effectiveness and suitability based on test results to date and other pertinent information.

We have made significant progress in the T&E resources area. The President's Budget for FY 1990 currently includes--for the first time--a consolidated, DoD-level funding line for test resources to significantly improve and update what is now a marginal national test capability. This Central T&E Investment Program calls for investment of $1.51 billion in fiscal years 1990-94 ($175.3 million in FY 1990) and will be managed by the DAB's Test and Evaluation Committee, established

in FY 1987 to coordinate and oversee T&E resource and policy matters on a DoD-wide basis. This program, augmenting and closely coordinated with the Services' T&E resource investment, is a dramatic and very important step toward assuring that, over the long term, we will have the participative and national-requirements focused test resources planning, management, and investment necessary to evaluate properly the highly sophisticated systems now under development.

To cope with critical short-term gaps in test resources, we have implemented our Operational Test and Evaluation Capability Improvement Program (OT&E CIP). Begun in FY 1988, managed by our office, and coordinated by the Test and Evaluation Committee, the OT&E CIP has given us the ability to quickly and very cost-effectively acquire urgently needed test resources, including actual threat systems. As the planning process and resource acquisition under the Central T&E Investment Program take effect, the OT&E CIP gradually will be phased out. The FY 1990 request for the OT&E CIP is $127.28 million.

Organizationally, we have grown significantly since 1985. When I took office, DOT&E had a staff of 11. Thanks in no small part to the continuing interest and assistance of the House Armed Services Committee and the active interest and support of Deputy Secretary of Defense William H. Taft, we now



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have 52 staff members, a number sufficient to carry out our duties effectively. Also, we have recently established a deputy directorate for strategic systems. This deputy is responsible for oversight of T&E matters for all programs under the cognizance of the Defense Acquisition Board Strategic Systems Committee (for example, B-2, MX Rail Garrison, SDS, and ACM). We have also added a science advisor, a reliability and maintainability (RAM) specialist, and an information systems specialist. These highly experienced and expert professionals assist our program oversight staff in the evaluation of test plans and results, provide expert advice to me personally, and aid in the development of T&E policy. In addition, the science advisor and our staff assistant for T&E policy and compliance are working closely with the Service operational test agencies and the Defense Systems Management College to significantly improve the T&E education of program managers and other acquisition and T&E officials. The FY 1990 funding request for the oversight, assessment, and advisory activities of our office is $25.72 million.

As I said at the outset, at bottom the role of test and evaluation in the acquisition process is to provide the discipline necessary to give <u>users</u> weapon systems and equipment that work the way <u>they</u> need them to, and to get them fielded when <u>they</u> need them. To do this job, T&E must be: operationally oriented; continuous from the beginning and throughout every program's life; and, above all, <u>independently</u>

conducted, assessed, and reported--reported with candor and objectivity.

This is what our office seeks to bring to the table every day--with the aim of continuous improvement of the defense acquisition process, improvement always being measured in terms of wiser production decisions leading to customer satisfaction: Do the men and women in the field get what they want and need when they want and need it? Does it do the job they want it to do? Do they consider it reliable and maintainable? We ask these questions of ourselves every day, and they form the standards by which we measure our fulfillment of the role of test and evaluation in the defense acquisition process.

Thank you, Mr. Chairman. I will be happy to answer any questions you and the members of the subcommittee may have.

Mr. DELLUMS. Thank you very much.

Mr. KRINGS. I might start out with an answer to a couple of the questions you posed.

Mr. DELLUMS. Please.

Mr. KRINGS. I guess the report card on how we are doing, in our judgment, I think we are doing well. I think that we are proceeding at a reasonable pace so that it is not a perturbation and will go away.

We clearly have to create the permanency of what we do. We don't want things to change when we are gone when there are changes here and changes in other places, because they are primarily disciplining activities and I think that that, more than anything, is what we need in the acquisition process, is discipline.

So that is what we are really trying to bring to the table, a form of independency that I think can create discipline is the way we can say it, and I think we have definitely moved in that direction.

The testing is better. The information you are getting to make budgetary decisions, the information that the program managers are getting to make programmatic decisions, are clear and have much greater candor than we have ever seen in the past.

The recipients for whom we all work indicate that the more recent weapons systems they receive do, in fact, work better, more often and are more reliable and effective than those that they got from a system that was probably a little less disciplined.

So our key answer is the user. If we go out and see the user operating the equipment that we have evaluated and he feels that it really does its job the way he wants to do it and what he needs to do, we have fulfilled what we are here for.

We would like to keep all the rest of the people happy while we are doing it, but we would mostly like to keep them happy with the product that they are getting.

The mention of our capability improvement line, I petitioned through the Defense Resources Board, which I am a member, on two occasions, trying to build up an argument, if you will, for the need to improve operational test capability.

It was urged by many people within the Congress and ourselves. We had what I felt was a need that was agreed upon by the Members of the Congress, ourselves, and clearly agreed upon by the testers themselves that we needed to fill the gap that had been created over the years in the capability to do operational testing.

There has been great funding to improve technical testing, wind tunnels and Cray computers, et cetera, but not in the field testing to see operationally if it does what the user really wants it to do on a realistic basis.

So we said clearly we have to improve our investment in test and evaluation resources but, even more, we have to accelerate getting things to the field so that we can test the emerging weapons.

So we can't wait 10 years to get a new wind tunnel and we certainly can't wait 10 years to get threats to go out and test the equipment we are buying today.

I was successful in convincing the DRB and Deputy Secretary Taft that the services were not doing an adequate job themselves of funding and procuring the necessities for operational testing. So

the obvious answer was why don't you get the money and do it yourselves? I said I would be glad to.

Now clearly we were not in the ownership and operation of operational test equipment business. We are in it now, but we would like to get out of it, but you have to start somewhere.

If it didn't exist in the service—and the other problem that we found is the services sometimes look at their own individual requirements and not necessarily on a national scale.

Most of our adversaries operate on a national scale. They are adversaries to the Army, Navy, Air Force, Marines and everyone, and they are rather a common adversary.

So we felt that there was justification for a common adversary technique here to do operational testing, that which is a threat to a Navy airplane is probably a threat to an Air Force plane.

So we needed to bolster this capability, but we didn't need to do it three times, one for each service. So we talked in terms of a national capability to improve a mobile capability. There has been a tendency in the T&E community that if you get a new T&E resource, you pour concrete around it and you own it and Mohammed must come to the mountain.

Unfortunately, it is generally in the desert on a clear day, and most wars are not always in the desert on a clear day.

We wanted the capability to be able to move these things to where the test was going to be and support and enhance the test that the service was doing. This necessitated, at least for the first couple of years, a central funding line and some central national focus on what we do.

We do not decide where the money goes. I have no control over where the money goes at all. This is a totally participative system. The process by which the determination is made as to what is bought is done by the testing people themselves. They come in, essentially take their uniforms off and become a purple objective national test advisor.

They sit down and they must come up with a prioritized national requirement. They are based solely on the tests that are going to be done. Nobody gets to buy new radar because he has an old, rusty one and would like a new one. He can only get into the system based on need. He has to show a test, when it is going to be done, where it is going to be done, and why you need that piece of equipment. He gets in the queue. This group of experienced testers decide the priorities and we execute them.

If they can't come up with a priority, we can give them one, but I think clearly their priorities are better than ours because they must execute the test.

So that is the mechanism. It is a totally participative mechanism by those who must execute the test. They decide the process. They decide who is in line, and people can come in and talk to me all day long about their new radar. They have to go to the source, get in line and have a very, very good argument connected with a real test.

We found out in this process that there is a lot of test equipment around that one person doesn't know the other person has or they both think that somebody else is buying. So just getting these people to coordinate their needs and their requirements has shown

that maybe in some cases we are not as bad off as we thought, we just didn't know where we were. In other cases, we are infinitely worse off than we thought we were.

This is the first time we have ever been able to bring all of one functional community together participatively and have them outline on a national basis what the priorities are. I would suggest very strongly if this budget line is ever attacked, to be reduced in any way, that you use this mechanism to reduce it rather than singling out anything in your budget deliberations to say I think I am going to decide that you get rid of this radar.

We have a mechanism that, if there is any reduction in budget, can go back and ensure we don't injure the most important ones, that we take them off the bottom, and we can respond very quickly to any cut like that with a thought process that includes the people who really have to do the job.

There are very few elements within the Department of Defense, I think, where we can do that. We have been very, very successful. The services were reluctant at first, but they are doing it now.

That is what that capability improvement line was for. It deals with, in the operational case, it deals with things that we need now, things that we need in 6 months, a year or 18 months. It doesn't look out 20 years.

The larger T&E investment program is a long-term total investment in all T&E facilities, but operational testing in many cases, we are going to do something next year and we don't have the capability to really adequately and robustly test that piece of equipment.

We are finding in many cases, rather than building a simulator and waiting for 5 years, we can legally, without any interference to anybody else, go out and acquire third world and Soviet type and Soviet weapons to test against, perfectly legally, without upsetting anybody and at rather low cost and, therefore, it is very hard to argue about the realism of dealing against a real threat.

It seems cheaper. It seems quicker. We definitely have to fill the void or we are not going to do the testing properly.

That is our capability improvement program and that is the way it works. In every program over which I have any control or input that is a budgeted program, that is the method that we use, a participative system by those who have to do it and a need-based generation of those costs.

So that is what we get. How we get it, anything we buy, we buy in the open. People know we are buying it. It is available to buy. It is perfectly legal and there is no jeopardy brought to any intelligence activity or any acquisition activity by anybody else. It has all been totally approved before we ever started doing anything. Those communities were well involved in everything that we have done.

Mr. Dickinson brought up the case of the Congress asking us to do standardized testing. It is right back to the thing that we were talking about before. It is a good idea because in many cases radar warning systems, whether they are on a Navy airplane, Air Force airplane or Army helicopter, are working against the same radar.

Number one, that is the reason to try to nationalize some of the capabilities of our testing because we are operating all three serv-

ices against, many times, a common standardized enemy, number one.

Number two, we can't afford to have each person have their own test capability and not put them together. It is just too expensive. Not all tests are done at the same time so we can share equipment.

So we have a plan to do that. It is being perfected, but clearly we don't want it to be just our plan. It is being iterated throughout services, so their considerations are being taken and it is being perfected and worked on, and it will hopefully have the coordination, but not necessarily always the total approval of all the services.

Thank you.

Mr. DELLUMS. Thank you very much, Dr. Krings. We appreciate your opening remarks and your response to the questions that both Mr. Dickinson and the Chair raised.

Let me go back to a couple of very basic points for the record. You and I have talked about this informally. You indicated that your focus is on what the user wants and what the user needs.

I would appreciate it if you would indicate to the subcommittee what you mean (A) by the user, and how does the user make those points known to you and other departments or offices, such as the Office of the Secretary of Defense?

How do you know that and how do they know what the user wants and needs? How did that get into the process?

Mr. KRINGS. We consider the user to be the end user, the soldier, Marine, et cetera, who has to use the weapon, whether it be the pilot or Navy fighter, whatever the event might be, that is the user.

We absolutely cannot believe that we are smarter than the user. In many cases there are people in the system who say, well, what the user really wants is, and what he really needs is, and sometimes they don't really ask a user and they don't respond to them.

Now we want an informed user so he is demanding of new and better products. He is not just happy with something that is shinier than the one he has. He has to challenge the technology to get what he needs and know what he needs.

But that is who we call the user, the end item operator, whether it again is the tank driver or the pilot or whoever it is.

The way we understand what he wants, there is a very sophisticated system in which the CINCs and others who are in the warfighting business express their requirements. Those requirements are then written as a mission needs statement, if you will, something that they have to overcome or be successful in.

They again get eventually interpreted all the way down to an operational requirement. That, in turn, the services then translate into a specification or equipment requirement. We interject ourselves at one point in that system and try to make certain that, in fact, the specification and the piece of equipment that is going to be acquired does, in fact, relate to the user requirement.

So we try to make an audit trail, if you will, from the original requirement as the process proceeds all the way up to the specifications that they are checking to, but ultimately the operational test that is going to be done.

If the operational test at the end doesn't really reflect what the user wanted in the beginning, there is no reason to assume we are

going to get the right thing. So in order to properly construct a good operational test at the end to determine whether it should be fielded, we have to look back and make sure that we have preserved through this process the real intent of the user.

So while we don't challenge requirements, the user writes the requirements, we try to ensure that they are not changed as the process goes through. It is the old story of telling the joke here, and it keeps going through five people, and by the time it comes out here it is a totally different story.

There should be a trail in which we can audit those requirements and make sure they are not altered for whatever reason they might be. That is the way we try to ensure that the operational test does reflect what the user really wanted in the first place, and there hasn't been an alteration in those requirements as they are translated from requirements to need to weapons systems to specifications, et cetera.

The Vice Chairman of the Joint Chiefs of Staff, Bob Herres, has really played a very significant role since his creation by the Congress, and he has done an incredible job of bringing to the Defense Acquisition Board meetings that message from the Joint Chiefs of Staff and from the commanders-in-chief as to requirements.

He recognizes, as the law says, that the unified commanders are the ones that determine operational requirements, and we are there to try to ensure that the unified commanders' requirements, operational requirements, make it through the system and they are not altered sometimes by parochial interests.

Mr. DELLUMS. Thank you very much.

You indicated earlier that you have had good influence on impacting the acquisition process in a positive way.

Can you give the subcommittee some specific examples of how you have been able to positively influence the acquisition process with respect to weapons systems, for example, that are presently in the field?

Mr. KRINGS. I will take one from each service. The first one, let's talk about LCAC. It is a ship—it is a landing craft that is air-cushioned vehicle. It is a huge air-cushioned vehicle that brings supplies and people from the ship that is sitting out at sea over the shore and obviously doesn't have to have a dock because it can also run over the shore.

When that program first started—it is a very necessary program in the eyes of the Navy and Marine Corps, very necessary—but it wasn't really working very well at all. It has a lot of operational and maintainability problems.

If we would have fielded as early as the Navy wanted to field originally, we would have had significant problems, and there is obviously less initiative and response to fix problems after they are fielded than there is to get them fielded in the first place.

So consequently, intervention in that program, rather serious intervention in that program, I think they now have LCACs in the field that are significantly better than what we would have gotten if we would have allowed that program to go into production and fielding early on in its life.

It has taken time and money, but it was an agreed-upon necessity. It was a reconfirmed requirement, but there was no require-

ment to put that weapon system out there if it wasn't reliable and didn't work.

So we intervened in that, and I think that at least from the Navy operators that are out there today, they feel that if you took a stake in the ground the day that we intervened and a stake in the ground today, they have a better product today than they would have otherwise.

In other words, it would have taken a lot longer to fix these things after they are out there over the years and, of course, you would run the risk in that particular period of time of having to use them.

So we accelerate the fixes, if there are going to be fixes, if they are going to be fielded, and we certainly bring to light those things that perhaps should not even be fielded in the first place.

We talked earlier about getting it early. At the point of production it is very, very late to find out you have got a problem.

An Air Force system, the LANTIRN system, we were involved very much in the low altitude navigation system. That goes primarily on F15s and F16s. I was a little bit more involved because I fly 15s and F16s, so I had a chance to go out and see how it works and fly with then, and we had other people who were involved.

We were very concerned about the workload of the single-pilot F-16. We were very, very concerned about the ability of the system to interface properly with the other systems that were in the airplane, and we did slow down the fielding of part of the LANTIRN for a while.

But again, the people that are out using the LANTIRN today, that are out flying it in F15s and F16s, agree it probably would have gotten fielded in a way that it wouldn't have been as effective and clearly they wouldn't be as far along in a system if they hadn't been stopped and been forced to fix the problem earlier.

So I think that that influence does, in fact, save time and money because it takes a long time to fix things when they get fielded because they are kind of out there and we are looking at something new and we never seem to prioritize the fixes in the field like we do the thing that is ongoing, without a serious jeopardy to the user of not getting his equipment, but clearly trying to do that.

One other program was an interesting one, was AHIP. Congressman Dickinson is an AHIP expert among us for sure. There was a fortunate situation in which we actually intervened, and I think in this particular case maybe we caused something to be fielded that might not have been fielded otherwise which is generally not our role.

We seem to be looked at as the ones who kill programs rather than make programs. In this particular case the Army did an operational test for three roles. The AHIP basically flunked two roles and they didn't get to produce the airplane in that role.

They did produce the airplane in the third role. One of the roles that they failed was not really the equipment. It was unfortunately a discipline or mentality that existed in the Army at that particular time as to who should be in the helicopter, and we didn't have the right people in the helicopter.

It was impossible to take advantage of the capabilities of that helicopter when you put an avionics system in a helicopter and you

keep the old crew chief to run it. It just doesn't work out very well. You need somebody who is trained for the job.

We felt that if they went back, reorganized themselves, came back and did a test properly, it would probably show that that equipment was worth what they were buying and would, in fact, achieve what they did. They did that, and they were successful.

I had the opportunity of going to the Persian Gulf last fall and flew an AHIP at night with the Army. What they did last year in the AHIP has contributed to us being able to essentially withdraw and be successful.

I think without some of our efforts, perhaps, they wouldn't have what it took to get done what they wanted to do. There are many other cases in which we do seriously impede the progress of the program because we find it to be faulty. Those are just some examples from the three services.

Mr. DELLUMS. Thank you very much.

Mr. Dickinson.

Mr. DICKINSON. Thank you. I appreciate the accolade, but I am really not an expert on the AHIP, but I, too, went to the Persian Gulf, and I agree with everything you said. Our night vision capability was the difference in success or non-success, and I think ultimately the cease fire that was brought about and the fact we no longer are having to escort the vessels really was due to our capability to fly and see at night. No other nation has that capability. So I think it was very successful.

As long as we are talking about Army and helicopters, what can you tell me about the Apache? Colonel Karrs, I believe his name is, Karrs—a letter that was in the paper a couple of days ago saying he would rather have an old Cobra than a brand new Apache because first the cannon doesn't work; second, the rockets are unreliable; third, the lamination on the—these are my words—propeller blades will become separated.

Now, Mr. Dingle is exercising jurisdiction over the problem instead of our committee. So what can you say about that since it came out of your shop?

Mr. KRINGS. Everything except the last because it didn't really come out of our shop. It was done before us, but that doesn't mean we are not watching it. We are still watching it.

Clearly in the case of the Apache, I think the colonel was quite successful. I think he did the right thing. Sometimes we all do that. Some of us shout a little louder in order to get heard.

Mr. DICKINSON. Before I am misunderstood, he was writing in his chain of command. He was not trying to make publicity. He wasn't going public with it. It was an official correspondence from him to his boss that somehow got leaked.

I didn't mean that in any derogatory way against the colonel.

Mr. KRINGS. I know. I think we both agree sometimes you do that. That is the way we should do things. These problems all existed in the Apache prior to that letter. They have been known for some time.

To the best of my knowledge, 2 days of looking into it, all of those things are in ongoing programs that are being worked. In other words, nothing in there is a problem that the Army is not

already thinking about and bringing engineering improvements to the field to fix.

There are none that are unknown how to fix. It is a process of getting, in some cases it is grommets and it is pins and mostly hardware reliability problems that are in the process of being fixed, and I don't mean like going to be fixed. I mean they are being fixed and the parts and improvements are being fielded.

So it is something the Army knew about. He accelerated this, as I would hope he would and others would. There have been instances, I might add, though, before and after his particular period at the gunnery range, other units did not enjoy the same problems he did. But they have over time.

It is not to imply those problems don't exist. I think in his particular case they kind of focused during a period of time he was shooting and their particular system had lower numbers than he would like, and he rightfully said we have got to get this fixed.

But I can assure you that everything I have been able to find out—and we have been looking very closely—it is nothing new. It is nothing that can't be fixed. It isn't anything that isn't being fixed, and one must recognize the Apache is not exactly a new helicopter.

Clearly when Apache was designed years ago, having worked for the company that bought the company that built Apache, it is the product of the 1960s. So reliability and maintainability when we, as the Government, bought Apaches, we really didn't know how to do that very well in those days and we didn't demand a lot.

It is not the only program and only piece of equipment like some of our cars that were built and bought in that time that have those kind of characteristics. We don't buy equipment like that today, but we have to live with what we bought. It is clearly not an engineering problem. Incidentally all qualified in gunnery while they were out there.

So it was a thing that commanders do and should do to excite their superiors to get things fixed a little more quickly.

Mr. DICKINSON. What can you tell us about the D–5 missile that did the pinwheel a couple days ago?

Mr. KRINGS. I know absolutely nothing about that except what everybody——

Mr. DICKINSON. That didn't happen on your watch?

Mr. KRINGS. No, sir. We will undoubtedly find out what did, and everybody hopefully will try to preclude that from happening again. It was quite a spectacular event, though.

Mr. DICKINSON. It sure was. I don't want to monopolize all the time, but if you could briefly talk about the JTIDs and advance cruise missiles and whether or not there is a question of unseemly delays in your testing program. When someone comes in the queue that you talk about, do you tell them to take a number and get in line, we will get to you? What sort of delays do they experience?

I would like to first just ask you to comment on the B–2 bomber which is running into problems especially with its funding.

What is it going to cost? They say half a billion dollars plus. Second, it is experiencing slippage anywhere from 18 months plus, and I think probably it run to two budget cycles. That puts it back 2 years which costs money and so forth.

There are serious people on this committee who think this thing is just too expensive for us to buy if it still has problems. A half a billion dollars. I have to have some qualms and reservations about it myself.

So give us a brief exposition or statement, whatever you would care to do, on the B–2, and then JTIDs. Please discuss that with us before you leave, if you will.

Mr. KRINGS. Obviously much of the discussion about B–2 is classified, and I certainly won't go into any of those areas. I don't think that is what you are asking about. So I think that we are comfortable in discussing the things that you are talking about.

Number one, the cost. As a tester, we would like to—we can't—we would like to not even consider cost because we are trying to see does it achieve the operational capability and is it reliable.

But we are not so unreasonable to recognize that that is a very, very vital part of any program. But we are very reluctant to talk about the cost, and I am.

Values, when you start looking at cost and what it does, maybe that is where we get back into it. When we have done more testing, and we know what it can do, we can come to the table and try to balance what it can do versus what it really costs.

To try to project what it really costs is not in my realm and probably shouldn't be, but the things we are trying to do with the B–2 is a very difficult task. There is no question about it.

As with most tasks, it is grossly underestimated. We do that not just with B–2s but a lot of things. One thing we have done from an operational standpoint in our office is very significantly different than any other program that we have done, and it is the result of B–1.

Two things that I alluded to earlier in my discussion called early operational assessments and maturity matrix. This is where we started, the concept of the maturity matrix was on the B–2 program.

As we all recognize, the first operational testing that was done on the B–1 was done after we bought them all, not some, but after we bought them all. We don't believe that is the way we should function. We don't believe that that is what the Congress wants us to do.

So we said how do we get into the B–2 program and give insight to the operational capability of the system while we are still building it, not after we have bought them all?

So we worked with Chairman Aspin and other Members of the House Armed Services Committee and the Senate Armed Services Committee at first not terribly with the services, but they did come along afterward and they came up with a system that is infinitely simple.

It is basically the same way you go to college. If you don't pass the test, you are not a sophomore. You agree to a curriculum before you start.

So we said surely there must be an agreed-upon plan to achieve operational capability of the B–2. Write it down and make a contract. Say that before you spend *x* number of dollars or buy *x* number of airplanes, you are going to achieve a certain amount of

capability even if it is only demonstrated in component testing and development testing.

But it is certainly a benchmark as to how well the program is going and we can compare what your score is, what your grades are before we buy another semester's worth.

Mr. DICKINSON. What you are saying is you are going against performance record instead of the calendar?

Mr. KRINGS. Exactly. It is a totally event-driven program. If they don't achieve what they said they were going to achieve, they said, not we said, they said they were going to achieve at these milestone points and large investment points, we will know where we stand.

We can pass this information to the decision makers in the Department of Defense and the Congress, and they can decide whether they want to keep going or don't. We don't decide whether to keep going. We give them the tools to decide with, based on what the agreement that they were going to achieve in the first place.

They didn't have this sort of insight before in many programs. We are applying this and it is basically a contract between the program manager in the service and the Department of Defense, OSD, specifically me, that they will, in fact, achieve this.

It is written down and it is relatively elaborate as to what they will do. It is certainly criteria they expected to make, and it is a presentation you can get a balanced argument about what it has promised to do and what it has shown it has done.

In many cases it will only be the product of component testing if nothing else, but it is the best evidence that you have at the time you make the decision. The Air Force has agreed on that.

We do have a complete maturity matrix on the B2 and we will do those, what we call early operational assessments by the independent tester to see where they stand in terms of evidence at that point.

The independent tester then moves away from the program and lets the developments testers, the advocates and the contractor, make it work, and then they go back in and see is it working.

So that's a major change in the way we are doing business. A very simplistic and natural thing, but not necessarily what we have been doing all along. We are applying this to other programs than the B-2, most all programs now.

Mr. DICKINSON. Thank you, Mr. Chairman.

Mr. DELLUMS. Mr. Pickett.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. Krings, we heard testimony yesterday that it is taking up to three times as long to get a weapon system from the drawing board into the field than it took 25, 30 years ago. Is your office contributing to the problem or the solution on this matter?

Mr. KRINGS. We would hope that we never slow down a working program. In other words, I personally feel—and we have done everything humanly possible to never alter the Service's intent to acquire and their acquisition profile.

Now if the development cycle takes longer, if the product doesn't appear to do what it is supposed to do, when it is supposed to do it, that is clearly, in my view, the product slowing the program down, not an outside person.

The testing, we suggest, we have not found to slow down a program in which the system is, in fact, working. We have many programs that have followed their profile of acquisition because when they were tested, they did, in fact, achieve that which they were supposed to do.

Clearly, if we go to a totally traditional type program in which we totally fly before we buy, and we try to buy production representative articles that really come out of a factory, built by those people and those subcontractors, we take them out and test them operationally for a year or 2 year and then go into production, we are then clearly slowing down the program.

But the worth of that has to be determined by people like yourselves as to whether or not we can do that. Can we stop the factory and go out and test for 2 years and then turn it back on again? That contributes some of it. Saying it takes three times as long to field, there are programs today that are being fielded very quickly. There is an Army program, the mobile subscriber equipment, which is basically a huge cellular radio system, telephone system for the Army. Uniquely, I was there when we were determining what the acquisition strategy would be, meaning we really didn't know what we were going to do, how we would buy it. I have been out in the field and seen it operate. That's only 3 years from the concept of doing it to being in the hands of soldiers really being operated.

We can do it quickly. We can do it effectively. The soldiers seem to be incredibly happy with their new cellular telephone system, I might add. We can do it right, if we do not prolong our decision making.

In many cases, things that take an awful long time to get out there, maybe they weren't very good in the first place. So it can't be done relatively quickly, but the risk goes up when you reduce the time because you just cannot hind-cast. You have to forecast.

Mr. PICKETT. My final question has to do with your office getting involved in those weapon systems that have already been produced that have developed problems in the field, i.e. the reference to the helicopters earlier. What is the process for your office getting involved in these kinds of problems or do you not get involved?

Mr. KRINGS. We do, almost by exception. Cases like this. Fifty-two people, obviously, you cannot look at the ones already out there. You can't even look at the ones that are below a certain threshold. Our legal requirement is to be involved and approve the tests and report on those programs that are selected acquisition report programs, those programs that exceed a rather large cost in R&D and acquisition. Those are the ones we are absolutely obligated to report on. We report annually. Of course, the report I talked about before, before full ready production and fielding.

We have two other avenues to be involved in programs. If the Secretary says, "I want you to watch this program," that's one way we get in. I can say I want to watch this program. I watch that program, even though they're not part of that original mandated list.

Now, when we look at programs that are already fielded, one of the biggest problems we have is our primary responsibility to give acquisition decision makers information to make decisions on ac-

quisitions. As the program gets older, this decision making goes down to lower and lower levels. In many cases, you all know, sometimes a fielded system, we almost jack up the license plates and drive a new truck under it. It is almost like a totally new program.

Where do you draw the line in modification that is equivalent to a new program? It's a rather nebulous line. We do not have the wherewithal to look at those new programs. What we like to do, though, is introduce the discipline. They can't get from A to B without doing it, but not necessarily with me watching.

We just physically—and I certainly never would propose we get to the size we do all those. We would much rather have them do it right and not have a thousand more checkers. It's too expensive. It certainly relieves them of the responsibility of doing it right if somebody is going to check on them.

Mr. PICKETT. Just a follow-up. My reason for asking that question is I would think in many cases you could learn something from the systems that get into the field and don't perform the way they should as far, especially pertaining to what your testing procedures should be.

Mr. KRINGS. We have what we call a feedback process. It is not just us. It's called Milestone 4. In the acquisition process, we have Milestones 1, 2, and 3. We are going to have the first Milestone 4 on the B–1. That is after it is fielded and it has been operational for a year or two, let's have a review then, see if it is doing what it was supposed to do. If it isn't, should we bring it up to that? Can we bring it up to that? What didn't we do right before then?

We are interjecting at that point the requirement for the service operational tester to be part of that review so that he can look back and see what did he ask for, what did we ask for on that operational test, what did it show, are they really meaningful? Are we asking the right things and looking at the right things? If we don't look at the system when it is fielded—which we are doing in a number of other systems in a less official way to see whether or not we ask the right questions and the answers that we got are, in fact, true when the real operators get out in the field and it really gives out in the field. That is the only way we can find out if we are doing a good job.

Mr. PICKETT. Thank you, Mr. Chairman.

Mr. DELLUMS. The gentleman yields back his time.

The Chair recognizes Mr. Bennett for such time as he may consume.

Mr. BENNETT. I have just two questions. Maybe we will get into this more. Your office has completed a draft report on the infantry and anti-tank tests which Congress ordered by provisions of law. I would like for you to forward that report to Congress so we can really use that information in our markup of the authorization bill.

Is that possible? When can you get us that report?

Mr. KRINGS. That report is, for all practical purposes, complete in assessing what we know right now. There are two other pieces of information. The report is due, I think, the first of June. But the report for all practical purposes on the information we currently have is done.

This is on an interim weapon system for the Army. There are two pieces of information that we felt were vital, could be obtained

within the time, and could be assessed so we get complete view. There is some information on the Milan system in which previously described weaknesses we have been told there is evidence in other testing, not just promises, but other testing that some of these weaknesses may have, in fact, been corrected. We said we don't feel it is proper if somebody believes that there is honest operational-type evidence to the contrary of what we found that we shouldn't include that. If that evidence is forthcoming, we will assess that as we have the others and include that with the June report.

Also, we have suggested that there hasn't been an awful lot of recent Dragon operational testing. Some of the data we have on the Dragon is—comes from exercises which is not necessarily done in the—data is not necessarily gathered in the same way from some of the military exercises and a lot of old development testing.

The Army is contemplating—and I say contemplating—doing additional operational testing with the Dragon. If they do, that information would be of value. So we would like to hold to the 1 June. We really have an answer on the data that we have right now, but at this point, we think it is unfair not to include something that somebody thinks is very important.

Mr. BENNETT. I certainly do not want you to leave out anything you think is important. But I do have the impression from what I have heard in casual conversation that either the Bill or the Milan are far better than the Dragon which is the thing that I am told is getting the better rating. I really want to get the best one we can get. I don't want to delay it. After all, we put it in the law because we were uncertain and disturbed last year, and if it came up this year, without having it made definite, I would be kind of discouraged about it because we really do want to know what the judgment is on these various anti-tank weapons.

Mr. KRINGS. About three-quarters of the way around the horse race, that's what it looks like. It looks like the end of the horse race is going to be pretty soon. No telling what might happen in the last quarter.

Mr. BENNETT. Unfortunately, the rumor seems to be leading us to the most unattractive of all the weapons.

Mr. KRINGS. Your horse is last.

Mr. BENNETT. The worst one is going to get the blue ribbon, even though it doesn't deserve it.

I don't have a choice myself. I am not wise enough to pick which is the best weapon. But I don't want to have a fuzzy thing come before Congress that leads us to pick the least attractive of all the weapons, and that is what I have a feeling we are about to do. I suggest we get good advice.

Mr. KRINGS. Even at this point right now, what we know, it's not a fuzzy answer. It's a very, very crisp answer. We just want to make sure we have not made a mistake by not including some information.

Your rumors are very true. That looks like the way the horses are lined up right now. The reason for those we cannot discuss here because some of them do have some implications.

Mr. BENNETT. I have no bias for any particular weapon. I just want the good, solid judgment of people that are studying it and their conviction of what is right.

Mr. KRINGS. I can assure you it will be a crisp answer. Even at this point, it doesn't look like it will be fuzzy.

Mr. BENNETT. Explain how the research is protected against incestuous domination in the operational testing process. Otherwise stated, is there a weakness in the testing process in allowing operational testing to be influenced by research testing?

Mr. KRINGS. It is the division——

Mr. BENNETT. Try to make this clear. I never understood it. I would like to understand it.

Mr. KRINGS. What you are saying is very clear. It is one of the most fundamental issues in testing; absolutely one of the most fundamental issues in testing. It goes again back to those who try to make it work and those who evaluate if it does. That is really what you are talking about. How do you make sure one is on one side of the line and the other is on the other side of the line?

Mr. BENNETT. If the same people are involved in making both tests, it seems dangerous to me.

Mr. KRINGS. It is, absolutely. It's not just dangerous. It has failed in many, many cases. It is exactly what we are trying to prevent. We do not want those who evaluate for decision making to be part of the process of making something work. Clearly.

So by using independent operational testers who are not charged with, involved with, or participate in making it work, we are now trying to separate the so-called development testers who, in my view, are the people who are trying to make it work, the engineers.

Mr. BENNETT. Is the process complete at the moment or not? Do you still have something to work on?

Mr. KRINGS. We still do.

Mr. BENNETT. You are doing it as fast as you can do it?

Mr. KRINGS. We are. Clearly, we are. Many years ago, it was totally separated. We went through an era of 20 years where it looked so attractive. Then you find out they become meshed, and now the evaluator is the guy yesterday who invented it. We just absolutely can't do that.

Mr. BENNETT. Can you absolutely stop that? Why is that a complex process to create that prophylactic situation?

Mr. KRINGS. What we would like to do is we would like to have insight independently during the development process so that the process can go on, but they are not the evaluators of how well they are doing. They are to themselves, but not to the decision maker and the money spender.

Doing things overnight we found is very difficult, but we are definitely going in that direction. The development testers, for the first time, the development test organization within the office of the Secretary of Defense absolutely and clearly, completely agrees with that. We have had to change a few people to get people who did agree with that. Now we have people who agree that there are two kinds of testing. There are two masters to which you respond when you test.

So, the fact that we have agreement and they are not arguing the case is a very major step.

Mr. BENNETT. Do you need legislation?

Mr. KRINGS. No, sir. Not now. I think we need revisiting legislation to make sure that we are not prohibited from what we want to do. We have discussed this many times, you and I and your staff and other people.

If we can come up with legislation that helps us get what we want to do and helps you get what you want to do, I think we are, in fact, discussing that. But not too broad sweeping changes that—we don't want to really perturbate the system too badly. We want to fix it. I think we can. I think we are going in that direction. Maybe not at the rate you and I would like to go, but we are certainly going in that direction.

Mr. BENNETT. I have no further questions.

Mr. DELLUMS. Mr. Darden is now recognized.

Mr. DARDEN. Thank you, Mr. Chairman. I apologize for not being here when the meeting began. I had a number of questions to ask Dr. Millburn, as well as Dr. Krings. Part of the risk we run as junior Members when we walk through, we are often called upon to fill in for the Speaker. I did my time this morning. I regret I was not here when Mr. Millburn was testifying.

Mr. DELLUMS. We will make sure your questions are submitted to Dr. Millburn.

Mr. DARDEN. I did read your opening statement. I wanted to point out before I question this witness, the Chairman in his opening statement touched on the two areas with which I was most concerned. As you well know, Mr. Chairman, we did eliminate the 14 percent cap in last year's authorization bill, but the cap arose the year before because of, I think, perhaps some potential abuse that occurred in the past years. I hope that the DOD and university research would be particularly sensitive to Congress' problem.

The other area the Chairman mentioned in his opening statement——

Mr. DELLUMS. I might just say to my colleague they plan to submit to us specific recommendations as to how to address the problems associated with Section 220.

Mr. DARDEN. I think Section 220 is a classic case of legislative overcorrection of a problem, Mr. Chairman. I appreciate your taking the initiative here.

I would like to ask my first question. I believe, Mr. Krings, on December 13 of last year Undersecretary of Acquisition Costello issued a memorandum urging that the procurement pipeline be cleared of contracts with universities not meeting the requirements of Section 220 as passed, even though the effective date of that would be October 1, 1989.

I assume and hope in view of the Chairman's statements and the discussion earlier with Dr. George Millburn that this information will be considered in the Pentagon and the pipeline not be cleared in anticipation of congressional action to clear up this technical drafting problem; is that a——

Mr. KRINGS. I am sorry, sir. I don't understand the area that I am being asked about.

Mr. DARDEN. Are you familiar with a memorandum issued on December 13, 1988 for the Secretary of the military departments

relating to service acquisition executives and directors of the defense agencies having to do with Section 220?

Mr. KRINGS. No, sir. I am not familiar with that.

Mr. DARDEN. I thought you would have been in, if you will pardon the expression, the line of authority here. Basically, what the memorandum does is direct people to clear the pipelines of contracts which might be in violation of 220 even before it went into effect.

Mr. KRINGS. Unfortunately, I have to express my ignorance. I don't know what 220 is.

Mr. DELLUMS. Those questions are better directed toward Dr. Millburn.

Mr. DARDEN. We will submit that.

My concern, Mr. Chairman, is that we not cancel all those contracts now in anticipation of a law going into effect which is so fatally flawed that we are going to, hopefully, change it before it goes into effect.

I will submit questions in writing then to Dr. Millburn to clear that up.

The only other area which I would like to take to Mr. Krings has to do with a followup of a line of discussion that was initiated by Mr. Bennett earlier. That is relating to requirements that were imposed upon the Department of Defense relating to our anti-tank capability.

Mr. Chairman, I think everybody who is involved in any aspect of our conventional defense would tell you that the most serious problem facing us at the conventional standpoint of our defense is our inability to kill a tank. I think we all are on board as to the AAWS-M Program, which we have already authorized and money has been appropriated to take effect several years away from now. But it is the interim system that gives us quite a number of sleepless nights knowing that right now we do not have the capability to kill an enemy tank.

From the information that has been furnished to the committee, from the tests I have had an opportunity to observe, it appears two systems, the Bofers Bill and the Milan II, appear to be superior in many ways to the Dragon. I don't have a preference for a particular system.

Mr. BENNETT. Neither do I.

Mr. DARDEN. I don't have a so-called parochial interest in any particular system also. It appears of the many systems that are interoperable with NATO, that are working, we ought to go ahead and pick the best system and not go through what at least appears to us to be some type of manipulation of the testing process so that the Dragon can raise its ugly head once more so we won't have this interim capability.

I would ask you in the strongest possible terms to get on with trying to get the best possible interim system as soon as possible, because if we keep on dragging our feet, which may be the purpose of this whole exercise, we will have the AAWS-M at one time.

I would like to submit some questions to you in that regard, but could you elaborate a little bit about what is going on here?

Mr. KRINGS. Yes, sir, I certainly can. I would not want to be accused of dragging my feet.

We were required by the Congress to report on 1 June. We will absolutely unequivocally report on 1 June. We will bring a very crisp answer. It will be an answer based on all the evidence that we can find without any influence by Bofers Bill, Dragons, Army, or whatever it is. We will certainly use evidence that comes from many of their sources because that's the only source we have. We, like the two of you gentlemen, have no ax to grind on which system works. As we mentioned earlier, and have said over and over, we are only concerned the user gets what he needs, when he needs it; and if he isn't getting what he needs, and should have, he certainly should.

Again back to what I was saying with Congressman Bennett. There is some question as to whether there is some evidence that hasn't been presented. But if you can't get your evidence in by the end of the horse race, you don't get there. When the door comes down, whatever we have, that's what we are going to make our judgment on. We are not going to continue the discussion because all of the participants, whether it is the Dragon, or the Bills, or the Milan, or anybody else, they knew what the deadline was. They knew what we were looking for. We were very explicit in what you wanted us to do. If they can't conform in this period of time, that's life.

Mr. DARDEN. Let me say, and this is certainly in no way intended to be disrespectful toward you or your office; however, the word on the street—and the word gets on the street around here pretty fast—there are very few secrets in this town. There are a lot of things that are supposed to be secrets that aren't true. I realize that, whether it relates to potential nominees or programs or whatever. I don't have to tell you about the abundance of information in this town, a large amount of which can be disregarded.

Having said that, though, the word on the street is the decision has already been made, that this has been more or less set up to buy some more Dragons and, frankly, the men out there in the field are complaining. That's what my concerns are. I wanted to be sure I told you what is being said, whether it is true or not.

Mr. KRINGS. It is probably the same thing that has been said in the little handout we got about the problems of buying weapons. Unfortunately, it's in the 80 percent category you referred to.

We are not making decisions on what to buy. We are representing the evidence of how well the contenders work. The Army or you all can decide what you want to buy. We really shouldn't do that. But I can assure you that the information that we have and the way it's been analyzed and the way it has been presented will be very clean and very defensible; and if any decision to buy is made before then, it certainly isn't made with the blessing of our investigation.

Mr. DARDEN. I have no reason to believe it is not.

Thank you, Mr. Chairman.

Mr. DELLUMS. Mr. Hertel?

Mr. HERTEL. Thank you, Mr. Chairman

It has come to my attention that there are problems with the competitive amendment we added last year, to be competitive in all areas of university research. I supported that. In the area of oceanography research, we found——

Mr. DELLUMS. Would the gentleman yield to me?

I might just indicate this is not in Mr. Krings' area of jurisdiction. That was Mr. Millburn, the earlier witness who is no longer with us. If you have any questions in that regard, we will submit them and have them respond for the record.

Mr. HERTEL. Thank you, Mr. Chairman.

I would like to work with you on that problem. I want to keep it competitive, but I also don't want to encourage the kind of investment some universities have done for experimental activities in the past.

Mr. DELLUMS. These issues were raised this morning.

Mr. HERTEL. I see that in your opening statement.

I have no further questions.

Mr. DELLUMS. The gentleman yields back his time.

The gentlewoman from Maryland, Mrs. Byron, is recognized for such time as she may consume.

Mrs. BYRON. Thank you, Mr. Chairman.

One of the things that has bothered me over the last several years is when we have been in the development stage of a weapon system, Congress before the procurement scenario, and the procurement, final development stage has arrived, we have requested a test and evaluation, given you all time, or given the department a timeframe to get those answers back to us.

Time and time again, it has been disregarded. I can probably refer to DIVAD as my main source on that issue. I told the program director that unless he was able to come up with the test, it didn't make much difference to do them if they couldn't give them to us in the timeframe we asked, because we were going to mark the bill for that spring, and they weren't going to be in it. What happens is we asked for tests. We asked for results. We don't get them in time. Then people wonder why a program gets into trouble.

I think when we are talking about evaluation, we need all the help we can get because it is not easy to put together the program and the authorization that we are responsible to. So when those programs are in jeopardy, the only thing I can tell anybody is to please get us those results because if we don't have those results, that's going to be the first one that will be on the cutting board because we don't have the test results and evaluation to back it up.

A lot of times, as you know, we go to the floor and have a lot of trouble with our bill. If we don't have any results from tests and evaluation, we are not going to do well on the floor.

Mr. KRINGS. In response to that, we have altered the sequence of the timing of the publishing of our annual report so that our annual report which is basically a report card on the operational test results of the programs that we are looking over arrive at the Congress in time for the Congress to look at and utilize in some of their budget deliberations.

It gets quite furious at that time going back and forth.

Mrs. BYRON. I had discovered very early on the cost of many of those tests and evaluations are enormous; and if the results aren't going to be here on time for us, you might as well save those dollars and not do the tests, because the program is not going to be alive.

Thank you, Mr. Chairman.

Mr. DELLUMS. The gentlewoman yields back her time.

Mr. Krings, we would like to thank you very much for your contribution. There are a few other questions the Chair would like to raise with the gentleman, but given the fact there is a vote on the floor and there are certain time constraints, I would just submit those questions and ask that you respond to us for the record.

[The following information was received for the record:]

CICA Exceptions and Section 220

Mr. Darden: The Competition in Contracting Act (CICA) describes competitive procedures for awarding contracts based on a small number of exceptions. These allow the Department of Defense some additional flexibility in meeting urgent technical needs. Do you concur that eliminating these exceptions, as Section 220 does, would place the Department at a disadvantage because it could no longer quickly secure expertise in the Nation's colleges and universities for critical research and development needs?

Dr. Millburn: We are concerned that eliminating these exceptions will place the Department at a serious disadvantage in its efforts to secure scientific and technical expertise quickly from colleges and universities. At present, a number of high priority Defense programs are executed by universities through contracts awarded under CICA-authorized exception provisions, an avenue that will no longer be available if Section 220 takes effect in its present form on October 1, 1989. This restriction, incidently, will not apply to any other federal agency. To award contracts for these important programs competitively will add months of delay and, in some cases, result in the elimination of university capabilities that have for years been in the forefront of certain technologies of vital importance to DoD. In some circumstances, proposed university research and development activities have intelligence and national security implications which cannot reasonably be accommodated in a competitive environment. The Department's inability to use CICA-authorized exception provisions would bring an erosion of this research resource which is critical to the timely performance of sensitive research and development. Congress has long recognized the special needs of the intelligence community and provided the CICA national security exception to provide that flexibility.

We are also concerned that Section 220 may impact the Department's university-operated Federally Funded Research and Development Centers (FFRDCs), such as Lincoln Laboratory operated by the Massachusetts Institute of Technology and the Software Engineering Institute operated by Carnegie-Mellon University. We are concerned because Section 220 provides no exclusion for FFRDCs even though the House-Senate Conference Report states that the conferees did not intend for Section 220 to apply to FFRDCs.

Mr. Darden: In your opinion, would the imposition of Section 220 as currently written effectively eliminate the use of universities for certain research projects involving quick turnarounds or classified work?

Dr. Millburn: There is every indication that it will. As presently written, Section 220 expressly requires the use of competitive procedures for all grants and contracts awarded to colleges or universities. Thus, for classified work or projects requiring quick turnarounds, the Department under Section 220 in its present form, would not be able to utilize the services of academic institutions, but would instead have only commercial businesses as a resource.

Mr. Darden: A December 13, 1988 memorandum from Robert Costello, Undersecretary for Acquisition, urged that the procurement "pipeline" be cleared of contracts to universities not meeting the requirements of Section 220, even though the effective date of the Section is October 1, 1989. It now seems likely that both the Department of Defense and the Congress will be seeking some technical modifications

to Section 220. However, universities will not be able to retain some existing technical resources if these resources are cut off while the issue is being resolved, which is precisely what Dr. Costello's memorandum recommends. Already universities not under long-term umbrella contracts are feeling the squeeze in a number of technical areas and expect to lose technical expertise very quickly. It would seem this proposal by Secretary Costello would significantly erode the technical base of our universities. What would be your recommendations for remedying this situation?

Dr. Millburn: First, it is important to point out that the Department fully supports the basic concept behind Section 220, i.e., to limit earmarking of DoD research funds. However, because of the additional, and from DoD's perspective, undesirable effects of Section 220, the prospect that Congress may seek technical modifications to Section 220 to remedy its undersirable effects is welcomed by DoD.

Dr. Costello's memorandum of December 13, 1988, was intended only to alert DoD components that Section 220 takes effect on October 1, 1989, and that they would not be able to use other than competitive procedures after that date. Unfortunately, some components incorrectly interpreted it as requesting an intended immediate stop to the use of other than competitive procedures in awarding contracts to colleges and universities even though ection 220 does not take effect until October 1, 1989. The purpose of Dr. Costello's memorandum was to assure that a smooth transition could occur without destroying the university research capabilities needed by the Services. Contracts using other than competitive procedures, and entered into prior to October 1, 1989, would reasonably be expected to extend for a period of time after October 1, 1989, to allow for an orderly competitive process to secure the research needs covered by those contracts. This was to help avert situations where half-completed procurement actions (using other than competitive procedures) would have to be terminated and the preparation time lost. The actual language in Dr. Costello's memorandum is: "It would be prudent for your components to take the appropriate actions to ensure that the pipeline of college and university awards is free of actions not using competitive procedures by (emphasis added) October 1, 1989." The use of the word "by" was intended to signal that the use of other than competitive procedures is acceptable and legal until that date and such contracts, of reasonable duration, could be awarded up to that date. To correct any possible misunderstanding of the intent of Dr. Costello's memorandum, we will recommend that another memorandum be issued, explaining in more detail the original intent.

Representative George Darden: Has that study (DOT&E Assessment of Interim Infantry Anti-Tank Weapon Operational Tests and Evaluations) been completed?

Mr. John Krings: The DOT&E Assessment is in the final stages of completion and will be provided shortly. It is hoped that some additional firing data on short range engagements can be obtained.

Representative George Darden: Can this Committee now have a copy of that (DOT&E) independent assessment?

Mr. John Krings: When the DOT&E Assessment is completed, the Committee will be provided a copy prior to the June 1, 1989 deadline.

Representative George Darden: Is it true that your analysis differs from that which the Army has made?

Mr. John Krings: Yes. The DOT&E Assessment rested more heavily on the latest operational tests (including DRAGON) than did that of the U.S. Army. This focus is consistent with the Public Law concerning the Selection of an Interim Medium Anti-Tank System (SIMATS). Prior to its detailed analysis, DOT&E in November 1988 expressed concern to the Army regarding the general lack of data from any source to evaluate the relative operational survivability of any of the SIMATS candidates and also questioned testing and evaluation against the criteria of the AAWS-M developmental objectives. The Army responded that sufficient information existed for it to recommend selection of the already contracted for DRAGON 2 from among what it considered to be unsatisfactory alternatives. DOT&E found the tank killing capability of the DRAGON 2 sufficiently low that recommending its selection based on relative suitability attributes is inappropriate. Relative gunner survivability remains an unknown, but survivability without a significant ability to kill tanks cannot be an overriding consideration. Therefore, DOT&E feels confident that it can recommend a selection from among the other two available weapons that is clearly the best of the three interim alternatives.

Representative George Darden: Has the Army discounted your report or tried to block it in any way?

Mr. John Krings: The Army cannot, nor has it attempted to, block the independent DOT&E Assessment. Formal and informal interacton with the Army has disclosed a firm Army position supporting the already selected DRAGON 2. As such, this position is at odds with the DOT&E Assessment. The Army has questioned the DOT&E Assessment on the basis of DOT&E's reliance on operational test data and its failure to take into account other subjective suitability and financial factors the Army feels are important. Some factors, including implementation costs and impacts on Army force structure, are considered by the Army to outweigh operational effectiveness.

Representative George Darden: Do you believe that the Army's decision to proceed with DRAGON 2 is consistent with the Congressional directive based on testing, to choose the most effective system?

Mr. John Krings: No. Based upon the DOT&E interpretation of the Congressional directive, supported by informal discussions with members of the Congressional staff, the Army's conclusion that the DRAGON 2 is the most suitable and cost effective weapon does not meet the intent of the law. It is the DOT&E interpretation that the Congress wanted the most operationally effective weapon in the hands of our infantry forces and that this choice would be made based upon operational test data addressing the attributes specified in the law. Again, the operational test hitting performance of the Army's selection is so low that it makes its other positive attributes moot points.

Mr. DELLUMS. We appreciate your contribution before these proceedings this morning.

Mr. KRINGS. Thank you very much.

Mr. DELLUMS. The Chair would like to indicate to my colleagues we will stand in adjournment until the week of April 4th, 5th, and 6th, that timeframe, when there will be information briefings for the Members that will be announced once details have been determined.

On that note, the subcommittee stands in adjournment.

[Whereupon, at 11:55 am, the subcommittee was adjourned, subject to the call of the Chair.]

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